USSR Report

EARTH SCIENCES

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METEOROLOGY

INEVITABLE CLIMATIC CHANGES

[Article by M. Budyko, corresponding member, USSR Academy of Sciences]

[Text] A powerful eruption of Agung Volcano occurred in March 1963 on Bali Island in Indonesia. Although such eruptions of an explosive character have long been known this event drew very close attention from scientists. And this was not true of volcanologists alone, who as they say are interested in such a phenomenon by definition. The eruption, or to be more exact, the events which followed it, were of the greatest interest to climatologists. Why precisely they? And why precisely at this time are climatologists turning their attention to volcanoes?

The fact is that in the 1950's, during the time of preparations for and implementation of the International Geophysical Year, there was a considerable expansion of the world network of actinometric stations. This made it possible to clarify the influence of volcanic eruptions on the solar radiation regime. The volcanic eruption of Agung was the first major event which should give an answer to the question as to how eruptions exert an influence on solar radiation and through it, on the earth's climate.

And in actuality, soon after the eruption changes in solar radiation were registered in different regions of the earth. Observations of the intensity of direct radiation in the territory of the Soviet Union indicated that beginning in late 1963 radiation decreased sharply. The same was observed in Western Europe, North America and in the central regions of the Pacific Ocean.

However, in observations made on high-altitude aircraft it was found that after the eruption of Agung there was a marked increase in the concentration of aerosol particles in the stratosphere. These particles, attenuating radiation, were propagated over the entire earth, from the south pole to the high latitudes of the northern hemisphere. Only a few months were required for their propagation and a high concentration persisted for about two years at most latitudes.

These exceedingly important observations were very timely. Precisely in these years climatology was at the beginning of a restructuring associated with changes in the structure of science itself.

A problem making the rapid development of climatology necessary was the anthropogenic effect on climate. The influence of man, causing changes in planetary climate, raised before climatology a mass of highly complex problems and at the same time served as a reason for its vigorous development in recent decades.

At the very beginning of work on this theme it became clear that the chemical composition of the atmosphere is changing appreciably. It followed from this that a radical change in planetary climate was inevitable and this is so important that in a number of countries specialists organized major investigations of the global change in climate with the use of methods which until then climatologists had used relatively rarely. Electronic computers and theoretical modeling took a firm place in climatology. It was transformed before our very eyes from a descriptive field of natural science into a precise science striving to give an answer to a very difficult question: how will the development of natural processes affect the earth in the future?

The restructuring of climatological research in a very short time, not more than 10 years (therefore many speak of a scientific revolution), made it possible to collect and analyze an enormous amount of material giving an answer to the question: what is now occurring with climate and what will occur in the immediate future? Studying the anthropogenic effect on climate, scientists could also understand many reasons for its natural changes which until the recent past had defied explanation.

When we speak of an anthropogenic change in climate it must be clearly understood that reference is to global changes, changes in climatic conditions over very great territories under the influence of macroscale atmospheric processes.

Until relatively recently it seemed that atmospheric processes, enormous in their scales and grandiose with respect to the quantity of energy used in them, were beyond the possibilities of their modification by man. Only 10, and especially 20 years ago, the overwhelming majority of climatologists would give a negative answer as to whether man can change the earth's climate.

However, already at the beginning of the 1970's the first proofs appeared of a change in the quantity of carbon dioxide in the atmosphere. Precise measurements were initiated only in the late 1950's and about 10 years were required for drawing an unquestionable conclusion from these observations: the quantity of carbon dioxide is increasing in the atmosphere from year to year. It is increasing in all regions of the earth. This process is developing almost with the same rate both in the tropics and in the middle latitudes and at the south pole. It was found that carbon dioxide can no longer be called a constant component of the atmosphere.

The principal reason for these changes is well known: the combustion (and the later, the more) of coal, petroleum, gas and other types of fuel containing carbon. But earlier it was assumed that all the additional quantity of carbon dioxide which enters the atmosphere as a result of man's economic activity is absorbed by the ocean. Such a hypothesis existed, although there were almost no confirmations of this. However, when precise observations were organized

it was found that more than half the carbon dioxide ejected into the atmosphere is retained there. And although the ocean contains a large quantity of carbon dioxide, the possibilities of its further absorption are rather limited. A study of gas exchange in the oceans indicated that although atmospheric gases relatively easily penetrate by turbulent diffusion into the upper well-mixed layer of ocean waters, this layer is almost saturated with carbon dioxide. Below this layer diffusion processes attenuate, which impedes the transfer of excess carbon dioxide into the depths of the ocean. Computations show that in the future the capacity of the ocean to absorb the carbon dioxide created by man will gradually decrease.

In the carbon dioxide balance a role is also played by other elements of the biosphere, especially plants and primarily forests. It must be remembered that there are two opposite mechanisms of the possible effect of the vegetation cover on the atmospheric content of carbon dioxide. The first is well known: plants, with an increase in their mass, especially with the spreading of forests, are absorbing more and more carbon dioxide. The second mechanism is operative in the reverse direction and is related to the cutting of forests. As we know, many of these forests are being annihilated on the planet, especially in the tropics where the cutting is not compensated by the planting of forests. Some quantity of carbon from the burning of forests enters the atmosphere. To be sure, this is appreciably less than the carbon dioxide which is ejected due to the burning of fossil fuel, but this quantity must be taken into account in the "receipts" part of the balance.

The increasing concentration of carbon dioxide in turn acts on the development of plants, which results in an increase in the intensity of photosynthesis. Even now an increase in yield is being registered in all countries: plants are "working" in a more favorable regime. This mechanism will continue to operate to some limit. There have even been discussions as to how much carbon can be taken into plants and to what extent this can slow the accumulation of atmospheric carbon dioxide which is now occurring. The following point of view has predominated: such an effect is of secondary importance and this means that vegetation cannot stop the process of accumulation of carbon dioxide in the atmosphere.

Much organic carbon is present in the soil, where it constitutes a considerable part of humus. Working of the soil also results in the entry of carbon into the atmosphere. But this is a relatively small quantity.

A fact worth noting is that in the modern epoch we are seemingly observing a change in sign of a process occurring in the geological past. In the course of hundreds of millions of years in crustal layers there was a continuous accumulation of carbon deposits from which deposits of coal, petroleum, natural gas and oil shales were formed. Now in an exceedingly short time, on a geological scale, the accumulated carbon is being ejected into the atmosphere. Whereas earlier the atmosphere very slowly lost carbon (the carbon dioxide concentration decreased almost tenfold in the course of the last 100 million years), now, in a few decades (!) the restoration of the ancient chemical composition of the atmosphere is occurring.

What is the role of carbon dioxide in the earth's biosphere? First, due to carbon dioxide the organic matter of plants is created in the process of photosynthesis, this being the basis for maintaining almost all forms of life on the earth. Second, carbon dioxide is one of the most important factors creating the greenhouse effect in the atmosphere. Atmospheric air, the same as carbon dioxide, transmits solar radiation rather well. But carbon dioxide and water vapor block a considerable part of the long-wave radiation escaping from the earth's surface into space. This creates a "warm blanket" shielding the earth from cooling. If this "blanket" did not exist, the temperature of the earth's surface would drop by approximately 100 degrees, the entire surface of the planet would be covered with ice and the existence of vegetation and animal organisms would become impossible, as it is impossible in the central regions of Antarctica. There is basis for assuming that a decrease in the concentration of carbon dioxide in the course of the Cenozoic was the main reason for the cooling of climate in this period and the appearance of ice sheets in the high latitudes. An evaluation of the role of carbon dioxide in formation of the greenhouse effect is very important for understanding variations of climate in the past and those changes which are occurring in our times.
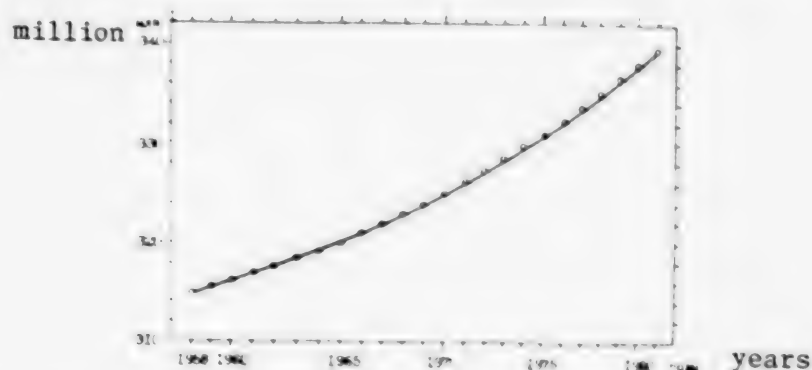
Results of observation of quantity of carbon dioxide in atmosphere at Mauna Loa station (Hawaiian Islands). The figure shows that the carbon dioxide concentration has appreciably increased. There is a tendency to an increase in the rate of carbon dioxide accumulation.
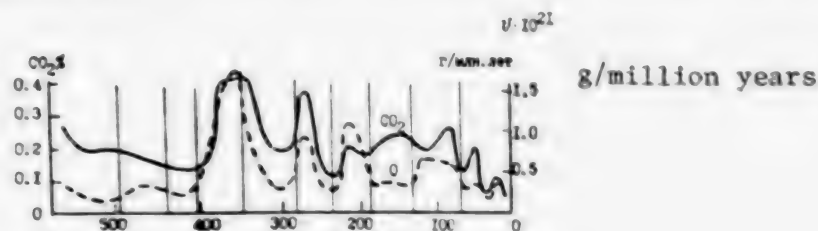
This figure shows the changes in carbon dioxide concentration and variations in the level of volcanic activity. It is shown that in the epoch of the maxima of volcanic activity the quantity of atmospheric carbon dioxide increased.

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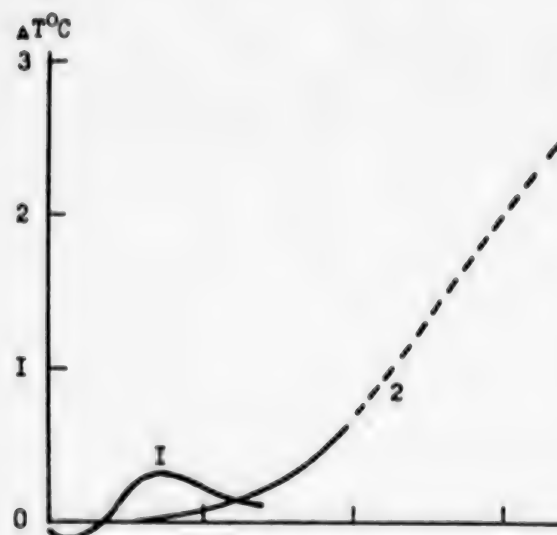
Curve 1 schematically represents the change in mean air temperature on the basis of observational data up to 1970. Curve 2 represents the anticipated change in temperature under the influence of an increase in the concentration of atmospheric carbon dioxide.

In the past, beginning with the end of the Mesozoic, against the background of a slow decrease in the quantity of atmospheric carbon dioxide, and therefore a gradual cooling, there were periods of brief coolings. These happened when there was activation of volcanic activity and volcanoes, together with lava and ash, cast different gases into the atmosphere. Aerosol particles which attenuated the effect of solar radiation were formed from these gases.

Now we have come back to that which was mentioned before: the relationship between volcanic activity and variations of climate on the earth. This is an important natural mechanism because it is capable of exerting a rapid influence on the climatic situation.

In addition to changes in the quantity of atmospheric carbon dioxide there are other processes determining climate but they all act slowly. For example, changes in the positioning of the continents and oceans on the earth's surface. When the oceans extend over spaces taking in both the high and low latitudes powerful currents develop in them which transport much heat from the tropics to the earth's poles. However, when the continents occupy the polar regions or surround them, limiting the influx of warm ocean waters to the poles, the temperature in the high latitudes drops and masses of polar ice are formed.

But whereas the continents change position over the course of millions of years, such natural phenomena as eruptions of volcanoes are capable of exerting an influence on variations of modern climate which persist for years or decades.

In order to be convinced that this relationship does exist we will recall the largest volcanic eruptions of the last century.

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During the last 100 years there have been several epochs of warming and cooling. The greatest warming began at the end of the 19th century. The air temperature gradually rose in the entire northern hemisphere in all seasons of the year. A particularly strong warming occurred in the high latitudes and in the cold season of the year. This warming accelerated in the 1910's and attained a maximum in the 1930's; by then the mean air temperature in the northern hemisphere had increased by approximately 0.6° in comparison with the end of the 19th century. In the 1940's the warming process had been replaced by a cooling which continued until recently. This cooling was rather slow, and not attaining the scales of the warming preceding it, was again replaced by a temperature increase.

Information on the modern change in climate in the southern hemisphere has a less definite character, but there is basis for assuming that in the first half of the 19th century there was also a warming there.

In the northern hemisphere at the time of the warming there was a reduction in the area of the polar ice, the boundary of permafrost retreated into the higher latitudes and the boundaries of forest and tundra advanced northward. The quantity of precipitation in the region of inadequate moistening became appreciably less, especially in the cold season. As a result there was a decrease in the runoff of rivers and a drop in level in some closed water bodies (we recall the catastrophic drop in level of the Caspian during the 1930's). There was an increase in the frequency of droughts, affecting great areas, in the intracontinental regions of the middle latitudes of Europe, Asia and North America.

However, there were also periods of temporary rather sharp coolings. They were all related to a decrease in radiation after the eruption of volcanoes. It would seem that there is some contradiction here. Volcanic effluent contains carbon dioxide and eruptions should favor an intensification of the greenhouse effect. And we see that a cooling sets in after a major volcanic eruption. This climatic paradox has been completely solved in modern research.

The atmosphere, together with water droplets and ice particles of clouds and fogs, also contains a great number of suspended solid and liquid particles of different chemical composition. It has been established that the atmosphere annually receives from the earth from 800 to 2,200 million tons of matter from which aerosol particles are formed. Man by his activity adds from 200 to 400 million tons of particles. Among the aerosol particles are the products of weathering of rocks and soil, sea salt from the surface of the oceans, soot and ash forming during the burning of forests and different kinds of fuel, and also matter arising as a result of chemical transformations of sulfur gas, hydrogen sulfide, ammonia and other gases entering the atmosphere from the earth's surface.

The mean lifetime of aerosol particles in the troposphere is about 10 days, which means that the atmosphere at all times contains about 30-70 million tons of aerosol. There are lesser amounts in the high layers of the atmosphere, in the stratosphere, but there it persists for a considerably longer time. Direct observations of the composition of stratospheric aerosol indicated that to a

considerable degree it consists of droplets of sulfuric acid. Sulfur gas, which enters the stratosphere from the lower air layers, there enters into a photochemical reaction with atomic oxygen. This gives rise to sulfuric anhydride, which, interacting with water vapor, forms sulfuric acid.

During explosive eruptions of volcanoes the most different gases, including those containing sulfur, enter the atmosphere. Some of this amount penetrates into the stratosphere. There tiny droplets of a concentrated solution of sulfuric acid are formed from them. The droplets in the form of a rather thick layer are propagated over the earth's entire surface.

Research on circulation processes in the stratosphere have shown that if the source of aerosol is in the extratropical latitudes the aerosol is relatively rapidly propagated within the limits of one hemisphere, but slowly penetrates into the other hemisphere. However, if the aerosol source (volcano) is situated close to the equator the aerosol is propagated in both hemispheres.

A discovery made relatively recently is quite impressive: a mantle of sulfuric acid droplets constantly hovers over our heads. Almost simultaneously this same layer was discovered on Venus. There the clouds of sulfuric acid droplets have an enormous thickness and hinder our observations of that planet. On the earth this layer is far thinner, but even with such a thickness it blocks some quantity of the radiation reaching the earth from the sun.

After strong volcanic eruptions the thickness of the sulfuric acid clouds increases and accordingly there is a decrease in the quantity of solar radiation incident on the earth's surface. Cooling occurs. When volcanoes are "silent" these clouds thin out and sometimes completely disappear and the climate changes in the direction of a warming. It is evident that the increase in radiation at the end of the 19th century was a result of clearing of the atmosphere from aerosol after the eruption of Krakatau in 1883. The aerosol particles held for a rather long time in the stratosphere gradually fell from it both under the influence of gravity and macroscale air movements, being transported into the troposphere where they were rapidly washed out by precipitation.

A decrease in radiation was observed after the eruption of Mount Pelée which occurred at the beginning of the 20th century. The eruption of Katmai volcano in Alaska in 1912, according to data from several actinometric stations in Europe and America, reduced direct radiation by more than 20%, and in some regions even more. For example, at Pavlovsk (near Peterburg), despite the enormous distance from Alaska, solar radiation was below the norm over the course of a half-year.

Beginning from the mid-1960's there was a calm in the activity of volcanoes and meteorologists registered a warming. But quite recently, in 1982, there was a powerful explosion of El Chichon volcano in Mexico. The Mexican volcano ejected a great volume of gases containing sulfur. Soon the thickness of the aerosol layer over the entire surface of the earth increased, affording us a remarkable possibility for registering what change in climate was caused by this event.

Thus, a singular "competition" is transpiring in nature. Carbon dioxide, blocking long-wave radiation, covers the earth with a warm blanket, similar to a greenhouse film; volcanoes, however, not admitting solar radiation to the earth, result in its cooling.

In general, during the last 100 million years there has been a predominance of a tendency to a decrease in the quantity of carbon dioxide and compounds of carbon taken from the atmosphere gradually accumulated in the earth's crust.

When there were disruptions in the balance of carbon dioxide variations in its content immediately led to a change in global climate. If there is more carbon dioxide in the atmosphere the air temperature increases, especially in the high latitudes, and the polar caps disappear, as has sometimes occurred in the earth's past. However, during coolings glaciations appear which cover more or less extensive areas.
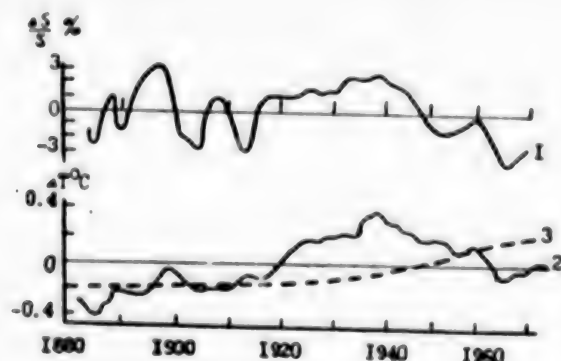
In this figure curve 1 characterizes variations in atmospheric transparency. Curve 2 shows the deviations of mean air temperature from the norm for the northern hemisphere. It can be seen that from the late 19th century to the 1930's the air temperature increased by approximately 0.6 degree. After the 1930's the warming was replaced by a cooling; by the 1960's the temperature had dropped by 0.3 degree, which was then followed by a new warming. Curve 3 shows the dependence of mean air temperature on the increase in carbon dioxide.

And now, when the processes of gain and loss of carbon dioxide in the atmosphere, transpiring relatively slowly in the past, have been replaced by its relatively rapid accumulation, the climate began to change. There is no longer any doubt concerning this.

But what are the quantitative characteristics of this process? As indicated by precise observations, as well as computations relating to a time when there were still no such observations, during the last 100-150 years the quantity of atmospheric carbon dioxide has increased by 20%. The mass of this gas in the atmosphere is very insignificant, only 0.03% of the total volume of the atmosphere. This quantity may be very tiny, but it already exerts a very great influence on the earth's thermal regime. And a change of this mass even by 20% cannot but lead to a change in global climate. During the last several decades the mean global temperature near the earth's surface has increased by a half-degree. It would seem that a half-degree is a small value, but it leads to consequences of great importance.

Can it be assumed that this process will stop or even change sign? I think not. Although there have been discussions of the possibilities of reducing the entry of carbon dioxide into the atmosphere, such ideas are not realistic. As a result of human activity the escape of carbon dioxide into the atmosphere increases with each passing year and therefore its accumulation in the atmosphere is occurring at an ever-increasing rate. This makes it possible to postulate with assurance that in the immediate future we can expect far sharper climatic changes.

Research by Soviet and foreign scientists show that evidently in the first half of the 21st century the quantity of atmospheric carbon dioxide will double in comparison with the preindustrial epoch. This doubling will lead to an increase in global temperature by almost three degrees. The warming will not end with this and it is possible th.t by the end of the 21st century the mean temperature on the earth will increase by five or even six degrees. To be sure, it is difficult to make predictions so far in advance because the scenarios of impending development of energetics become increasingly less reliable. But for the first half of the next century a forecast can be given quite reliably: an increase in temperature will occur and the consequences caused by this will require very profound study.

What will a change in global temperature by three or more degrees mean? Computations and observations show that during a global warming the temperature increases nonuniformly. It varies little in the tropics, but on the other hand in the middle and high latitudes (especially in the high latitudes!) it will increase very strongly. Therefore, an increase in mean global temperature by three degrees will evidently lead to very great changes at our latitudes and at higher latitudes and will have an influence primarily during the cold season of the year. Computations made using different models of climatic change show that with a temperature increase over the entire earth the regions with negative temperatures in winter will disappear. Winter, in the modern understanding of this word, will cease to exist. Temperature decreases in winter, to be sure, will stop, but in very rare cases will briefly fall below zero. Snow and ice, including ice in the polar seas, will disappear.

What will be the fate of polar ice? This is very important to know. It was clarified that the ice, which now covers enormous expanses around the poles in both hemispheres, is not only a result of the low temperatures in the high latitudes, but also to some degree its cause. It is also the reason for the cold winters in the continental regions of the northern latitudes. The fact is that ice has an interesting peculiarity. The ice cover reflects about 80% of the solar radiation incident on it and as a result of this after its formation conditions are created for further cooling: ice does not absorb solar rays but reflects them. As a result, with an increase in the ice cover the temperature continues to drop. It must be mentioned about this role of the ice cover in order to understand what would result from its partial and then its total disappearance. It is postulated that by the end of the first quarter of the 21st century the sea ice in the Arctic and Antarctica will completely disappear. It will become considerably easier to sail in the polar oceans. But that is not what is most important.

It is sometimes assumed that the melting of sea ice will cause a great rise in the level of the world ocean. This is incorrect. After all, existing sea ice is almost completely submerged in water, and this means that with its melting there will be no significant rise in the ocean level.

The matter of the prospects of melting of large continental glaciers is far more complex. There are only two such glaciers on the earth: the largest is the Antarctic glacier and the second is the Greenland glacier. Each of these glaciers contains an enormous mass of water. The melting of this ice (and not sea ice) can lead to a marked increase in the level of the world ocean. Simple computations based on energy schemes lead to the conclusion that neither the Antarctic nor the Greenland ice caps in the course of even a very sharp global warming would melt rapidly. Is it possible that a danger of a rise in level does not exist? But relatively recently the American geologist Mercer expressed the hypothesis that the Antarctic ice cap in the course of a global warming will be destroyed, since some of it does not lie on a continental basement but seemingly hovers over the sea floor. Accordingly, when a temperature increase occurs the shelf glaciers can be destroyed and part of the glacier will become unstable. This part will not melt but will be destroyed purely mechanically. The mass of ice, breaking off into the ocean, can raise its level by five or six meters. The consequences of such a level rise would be very grave for many cities situated on the shores of the seas and oceans. To be sure, the Mercer hypothesis for the time being is only a hypothesis. It is being discussed by scientists who have expressed the most different opinions concerning it, but it has not been refuted.

It is also necessary to examine a great many other very important consequences of the warming which will occur in the coming decades. In particular, there will be a change in the conditions for the existence of permafrost soils which now occupy enormous expanses over the territory of our country. The permafrost regions are gradually beginning to retreat northward and eastward. At first glance this is a positive effect of warming. But after all the existence of permafrost is also closely associated with the hydrological regime of the territory and with the nature of vegetation and with the economy in these regions. If one link in the chain is changed all the others change. The consequences of such changes can also be unexpected.

Large changes will occur in the precipitation regime. The falling of precipitation to a very high degree is dependent on the temperature distribution. And not only on the temperature itself, but also on the temperature difference between the high and low latitudes, which exerts an influence on the quantity of falling precipitation. The temperature field will become different, and to be sure, the quantity of precipitation will change. The computations which Soviet and foreign researchers have made in recent years show that with a warming in most of the continental regions of the earth the quantity of precipitation will increase. In most cases, but not in all. There is an economically rather important zone, from 40 to 50 degrees, where in a number of regions the quantity of falling precipitation can decrease. To be sure, there is nothing good in this for the countries located there.

How will anthropogenic changes in climate be combined with those natural vari-
ations which the earth's climate has always experienced and will experience?
It is now clear that explosive volcanic eruptions at times lead to variations
of the same order of magnitude as human activity. It appears that in our epoch
the effect from the natural and anthropogenic influence on climate is compar-
able, more or less identical, and the changes can be superposed on one another.
When a natural warming occurs it is rather considerably intensified due to an-
thropogenic factors. The cooling, however, is almost completely compensated
by the warming caused by human activity.

If early in the 21st century the mean global temperature rises by one degree
(some scientists assume even by a somewhat greater value), since volcanic erup-
tions are capable of changing temperature by only tenths of a degree it is
clear that their role will become appreciably less than the role of anthropo-
genic warming. After several decades, in the mid-21st century, if the present-
day rate of entry of carbon dioxide into the atmosphere persists, the tempera-
ture will increase further by several degrees and the role of natural factors
in the modern change in climate will amount to virtually nothing.

Global warming exerts an enormous influence on all elements of the biosphere
and can have such scales that it is difficult for us to even visualize them.
Why will the change in the biosphere be so great? Paleontology and paleogeo-
graphy will give the answers. Millions of years ago the mean temperature at
the earth's surface was above the modern level by 3-5°. That is precisely the
degree of warming which we expect to have in several decades. And the nature
of the earth, as we know, was then completely different. The temperature dif-
ference between the equator and the high latitudes was relatively small. Ever-
green plants penetrated to the shores of the Arctic Ocean and were even en-
countered on its islands. Heat-loving flora also occupied the entire area of
our country. Middle-latitude fauna was in many respects similar to the fauna
of the tropical countries.

It is understandable that such a picture cannot be restored immediately when
there is such a rapid warming. This process will be so gradual that even now
it is clear that it will be hard to detect. The rates of northward advance of
heat-loving plants is even now difficult to visualize. For example, in the
neighborhood of Moscow or Leningrad it will be possible to cultivate peaches.
But another climate has a different distribution of precipitation and tempera-
ture, a different length of the growing season, changes in soils and discharge
of rivers, direction of the winds and insolation, and much, much else. In oth-
er words, another climate is a completely different management system. The re-
structuring of agriculture, industry and transport, and in essence all ele-
ments of the economy, are related to change in climate.

It is rather difficult to evaluate the overall economic effect from the anti-
cipated global change in climate. It can only be postulated that for our coun-
try, a considerable part of which is situated in a region of cold, and some-
times very cold climate, the positive effect from warming will outweigh the
negative effect. Without question, there will be an increase in the possibil-
ities of economic exploitation of territories with an unfavorable climate, but

to be sure preparations must be made for all the anticipated changes, and this means that everything must be carefully studied and weighed. It is very difficult to change the economic structure which has taken centuries to develop in a few decades. Naturally, at the present time we cannot foresee all the consequences of a warming. The prospects for future change in the environment are being carefully researched. But it is even now clear that they are inevitable. [Material put into final form by G. Sheveleva.]

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OCEANOGRAPHY

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UNDERWATER VEHICLES FOR STUDYING FISHERY AREAS

[Article by A. N. Dmitriyev, Giprorybflot]

[Text] In 1953 scientists of the Pacific Ocean Institute of Fishing and Ocean-
ography for the first time used the GKS-V hydrostat for studying commercial
fish and the operation of fishing gear.

The hydrostat had five ports through which the observer scrutinized the water
space. However, the hydrostat could function only in the upper water layers,
well illuminated by the sun.

During a short period (from September 1953 through July 1954) specialists of
the Pacific Ocean Institute of Fishing and Oceanography submerged more than
80 times. In the years which followed the hydrostat was used in implementing
a research program outlining the principles for use of underwater vehicles in
fishing. A study was made of the behavior of marine animals, including the
reaction of fish to sound and light and the density of fish schools was de-
termined. It was demonstrated for the first time that a fish does not react
to ultrasound (fish reconnaissance echo sounders). In addition, observations
were made of operation of a bottom trawl and the method for diving and under-
water observations from the hydrostat was worked out. In actuality, not only
a knowledge of theory, but also practical skills are necessary for safe de-
scents into the depths of the ocean waters. However, the lack of searchlights,
lack of the necessary instruments and the shallow depth of submergence have
limited use of the GKS-V hydrostat. Accordingly, a decision was made to de-
velop a hydrostat capable of operating to depths as great as 600 m.

The submarine "Severyanka," reoutfitted for fishery research, was put into
operation in 1958, and in 1961 the "Sever-1" hydrostat, developed by the
Giprorybflot and constructed at one of the Leningrad yards, was put into use.

The time had come when the ocean depths had become accessible for fishing
specialists, oceanologists and geologists. The first explorers of the ocean
depths in underwater vehicles were O. Kiselev, V. Korotkov, M. Aronov, M. Zaf-
erman, V. Ditner, V. Zaytsev, I. Lagunov, A. Alekseyev, D. Radionov, L. Solov-
'yev, and others.

The "Severyanka" submarine and the "Sever-1" hydrostat were used in exploring extensive regions of the Barents Sea and the North Atlantic. an estimate of commercial reserves was made and a study of the behavior and migration of fish was initiated. These studies demonstrated the high effectiveness of underwater scientific expeditions and made it possible to formulate the technical specifications for new, more modern vehicles.

The research revealed that in study of operation of fishing gear it is necessary to have a fast-moving towed (or self-contained) maneuverable manned vehicle, whereas for studying concentrations of commercial fish, especially for determining the density of the concentration of cod, haddock, platus and other bottom fish, as well as crustaceans, it is necessary to employ an abyssal self-contained vehicle.

In studying and monitoring the functioning of trawls, as well as exploring the bottom, the Giprorybflot designed the "Atlant-1" one-man towed underwater vehicle, which successfully underwent tests and was put into operation in 1963.

Fig. 1. "Sever-1" hydrostat.

The vehicle has "wings," rudders, four ports, five searchlights and a flash-lamp for photography. A ship tows the vehicle at depths up to 100 m.

The use of the "Atlant-1" vehicle made it possible to demonstrate the possibility of developing new trawls for catching greater numbers of fish. This vehicle served as a prototype for a two-man towed underwater vehicle, the "Tetis," intended for work at depths as great as 300 m. Since 1973 the "Tetis" submersibles have begun to operate in fishery basins.

Two hydronauts occupy the "Tetis" submersible on special couches: at the left, the commander, controlling the vehicle, at the right, the observer, registering observations on a magnetic recorder, and also maintaining communication with the towing ship.

The "Tetis" towed submersible came into wide use due to the successful research in studying and adjusting the trawl. Earlier the trawl was lowered

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over the side when data were available on fish concentrations obtained using
a fish echo sounder. The volume of the catch was a criterion of trawl adjust-
ment: it was assume that the greater the number of fish trapped, the better
was the trawl adjustment. A small catch was evidence of trawl defects and these
could be detected only using a submersible.
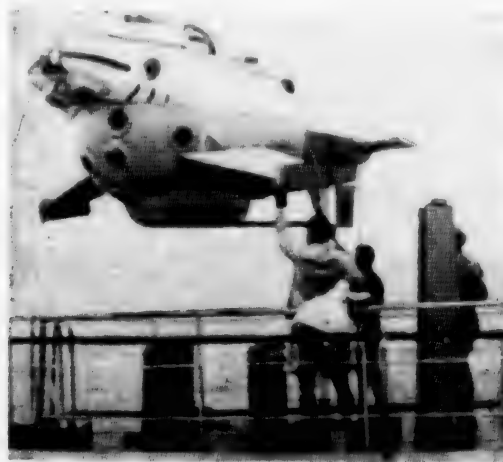
Fig. 2. "Tetis" towed submersible.

Fig. 3. "Sever-2" abyssal vehicle.

A trawl is adjusted in the following way. The trawl is lowered into the water from a fishing ship and when it is straightened out the "Tetis" submersible descends. The task of the hydronauts is to find the trawl using a small light or acoustic beacon on the trawl and in the light of the searchlights to inspect it. The entire trawl must be inspected in order to confirm its correct adjustment; it is necessary to check whether the bag has become twisted, whether there is a break in the net, whether the cable connections have snapped, whether the spacing boards or panels are askew. The detected defects are photographed and information concerning them is sent by telephone to the trawl supervisor. In case of necessity the trawl supervisor himself can take the place of the observer and examine the trawl in a working state under water.

The trawl, having defects, is raised onto the deck and the detected shortcomings are eliminated. Then the trawl is again lowered into the water and its final inspection is made from the underwater vehicle.

Research experience has shown that only 1 of 25 trawls lowered over the side assumes its proper configuration underwater and the shortcomings of the others can be eliminated only when they are raised onto the deck and with repeated underwater examination. Inspections of the trawl in a working state made possible a decrease in the time required for its adjustment and resulted in a 20-30% increase in the fish catch. Using towed vehicles it was possible to develop high-catch trawls for the taking of bottom and pelagic fish, shrimps and squid.

The search for fish is a constant concern of fishermen. If there are no indications of their presence the trawls are not lowered into the sea.

It has been assumed that fish do not live at depths greater than 600 m. But when Jean Piccard in 1961 saw fish on the bottom of the Mariana trench (depth 11,000 m) through a port in the "Trieste" bathyscape the debate ended and fishermen began to be interested in whether there are commercial concentrations of fish at depths of 2,000-4,000 m.

The "Sever-2" submersible for work at depths of 2,000 m, designed by Giprorybflot, was put into operation in 1971. The "Sever-2" vehicle operates together with a base ship. Six men can be held in a durable hull with a length of 9 m and a diameter of 2 m. At the prow there are seats for researchers, a control panel for instruments outside the vessel and manipulators. Seven ports make possible observations, motion picture and still photography surveys. The commander and the ship's engineer, situated in the middle part of the craft, are responsible for abyssal submergence. Mechanisms and the life support system are at the stern. The storage batteries of the hydraulic systems and all other mechanisms and devices are installed on the outside in a light hull. The great depth of submergence, autonomy, noiselessness, good working conditions and the necessary scientific research instruments advantageously distinguish the "Sever-2" from other submersibles. This vehicle does not frighten away marine animals and in a single dive makes it possible to obtain reliable and complete information from a great bottom area, something which can be accomplished by no other means.

During the last five years the "Sever-2" has been used in carrying out research making it possible to detect commercial concentrations of fish and crustaceans, and in some regions to reckon the absolute numbers and total biomass of fish and to improve the method for predicting the catch of different animals of commercial value.

The "Sever-2" is completely effective in combined research carried out jointly with hydroacoustic instruments installed on a base ship. The shipboard search fish sounder screen displays the entire school of fish and the "Sever-2" moving through it. At the same time, researchers in the submersible can calculate and in addition photograph how many fish there are per unit volume of water or bottom area. Using these results it is possible to make a quite precise determination of the mass of fish, the magnitude of the admissible catch and to predict future catches.

The pioneer of the Soviet deep-water fleet, the "Sever-2," already for 12 years has been used successfully in studying the biology of great depths.

The "TINRO-2" submersible was developed for research in Far Eastern seas. Its first dives were carried out in the Black Sea in August 1973. The "Gidronavt" and "Gidrobiolog" ship-carriers were constructed specially for vehicles of this type.

During 10 years of work researchers and hydronauts in the "TINRO-2" vehicles repeatedly submerged into the depths of many seas and oceans. For the first time scientists learned that on a rocky bottom there are considerably greater concentrations of fish than on a flat bottom. It was possible to establish the means for bringing together or frightening off of fish by light or acoustic signals. Research revealed that some fish are distributed in the water layer in layers; in many cases the upper school "covers" a lower school, which is not detected by the fish echo sounder. Using the "TINRO-2" vehicles researchers have obtained more exact ideas concerning the distribution and reserves of different species of fish, invertebrates and algae.

It was established in a study of the operation of fishing gear (stages, traps, nets) that many of them require a radical reconstruction or a change in catching methods. Trawl supervisors, ichthyologists and captains of fishing ships participated in numerous dives.

Underwater research in Far Eastern seas, especially the Sea of Okhotsk and the Bering Sea, entails great difficulties: frequent storms, winds, low air temperature, all this complicating the lowering and raising of the vehicle onto the base ship. The great turbidity of the water, especially in the bottom layer, makes the implementation of observations difficult.

Strong currents up to 6 knots in many cases carry the vehicle off course. However, despite the difficulties which arise the study of the biological resources of the Far Eastern basin is continuing.

The behavior of marine animals and their hunting, as well as their interrelationship with the environment, yield highly valuable scientific information for understanding the biological processes transpiring in the seas and oceans.

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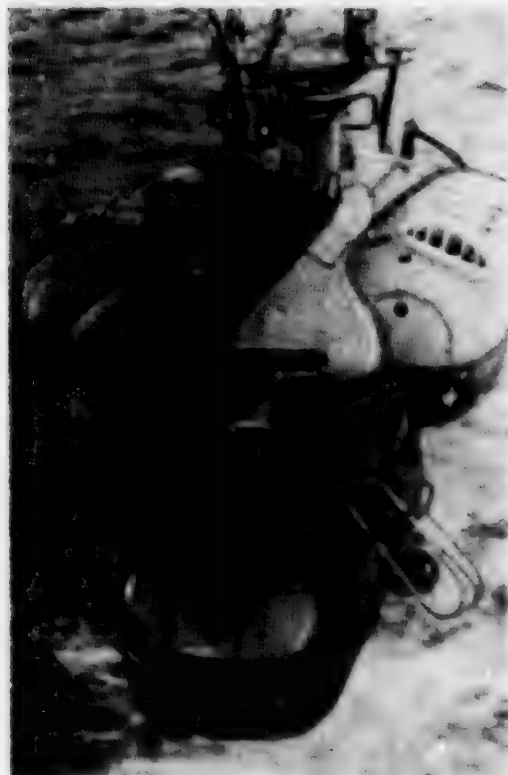
Fig. 4. Raising of the "TINRO-2" submersible aboard the carrier-ship after sub-mergence.

All the submersibles are intended for single-shift work of a crew. However, the experience of work on the "Severyanka" indicated that the study of many processes and phenomena requires prolonged research over the course of many hours, days and even weeks. Such research is necessary for studying the life of marine animals and plants, their interrelationships and the effects of the environment on them in order to solve the problems involved in increasing the bioproductivity of individual regions and the development of submarine farms. An order for the designing of an underwater laboratory was sent to Giproryb-flot by scientists of the Pacific Ocean Institute of Fishing and Oceanography in 1965.

The first "Bentos" laboratory was put into operation in 1976 and was for use in prolonged biological, hydrological and fishery research and the implementa-tion of different experiments at depths as great as 400 m.

The laboratory was outfitted with a wide range of instruments and devices for visual observations, motion picture and still photography surveys, taking water samples, the creation of light, acoustic and chemical fields in the surrounding medium, for studying the behavior and reactions of sea animals. The diving com-plex enables researchers to emerge in light gear at depths as great as 30 m.

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A crew of 12 men is housed in 4-man cabins. There is a wardroom, galley, pantry and sanitary compartment. The system for thorough processing of the air ensures normal conditions for the life and work of the hydronauts. One of the means for ensuring safety in diving is an observation-rescue tower in which, in an emergency situation, the crew, abandoning the laboratory, can float up to the surface and then proceed to the support ship.

In the course of operation there was a considerable expansion of the tactical, technical and research possibilities of the laboratory; in particular, a method was developed for the underwater towing of the laboratory by a support ship, making it possible to investigate extensive botto areas. A method for the mapping of the bottom and calculating the reserves of phyllophora, mollusks, mussels and oysters was developed and introduced, methods were developed for catching fish in the light and masses of algae and mollusks were discovered upon the rising of hydrogen sulfide into the upper layer of the sea. The undersea laboratory has been used successfully in the search for and the raising of sunken objects and in performing missions for marine geologists and petroleum specialists.

The experience in use of the underwater laboratory has been used in developing more perfect completely self-contained second-generation self-propelled laboratories.

A decade of experience in using underwater vehicles and laboratories has confirmed their high efficiency.

5303
CSO: 1865/107

RESULTS OF ATLANTIC-MEDITERRANEAN CRUISE OF RESEARCH SHIP 'VERNADSKIY'

Kiev PRAVDA UKRAINY in Russian 14 Jun 84 p 4

[Interview with A. Yu. Mitropol'skiy, head of a laboratory of the
Ukrainian Academy of Sciences' Institute of Geological Sciences,
by V. Petrenko; date and place not specified]

[Excerpt] "Pravda Ukrainy" recently published a report that the scientific
research ship "Akademik Vernadskiy" had returned to Sevastopol' from a long
cruise. Candidate of Geological-Mineralogical Sciences A. Yu. Mitropol'skiy,
head of a laboratory of the Ukrainian Academy of Sciences' Institute of
Geological Sciences, told about interesting discoveries that were made dur-
ing this expedition:

"During our 28th cruise, studies were conducted for the most part in the
tropical Atlantic, and also in the Aegean and Black Seas," related
Aleksey Yur'yevich. "The expedition's program was drafted under the direc-
tion of Ye. F. Shnyukov, member of the Ukrainian Academy of Sciences. One
of the program's most important tasks, one that has been a prominent feature
of our expeditions in recent years, involved what geologists call comparative
metallogeny. Comparison and summarization of large amounts of factual material
gathered during these expeditions help to understand better details of the
formation of metalliferous deposits in various regions of the world's oceans.

"Multilayered segregations of ferromanganese nodules containing nickel, cobalt
and other valuable components in addition to iron and manganese were dis-
covered by the expedition in a trough in the central part of the Atlantic,
during studies of rift valleys and faults which intersect the huge Mid-
Atlantic Ridge. Rather large deposits of phosphorites were discovered near
the African continent.

"We also conducted studies near the island of Thera (Santorini) in the
Aegean Sea.

"One very interesting event of the expedition was what I would call a
'second encounter with an unknown submarine volcano.' This was when the
cruise of the 'Akademik Vernadskiy' took it into areas of the Canary Basin
in the Atlantic which I had occasion to visit almost 15 years ago. We
pulled up rather young basalt rock which was from a volcano on the ocean
floor.

FTD/SNAP
CSO: 1865/213

RESEARCH SHIP 'BOGOROV' COMPLETES INDIAN OCEAN CRUISE

Moscow VODNYY TRANSPORT in Russian 24 May 84 p 4

[Text] Far East scientists have discovered new types of marine organisms whose tissues contain valuable biologically-active substances. Some of these "sea medicines" possess high antimicrobic properties and the capability of transmitting stimulation signals through nerve cells.

Such are the results of the 17th cruise of the scientific ship "Professor Bogorov", which has returned to its native shores from the Indian Ocean.

FTD/SNAP
CSO: 1865/213

RESEARCH SHIPS 'MENDELEYEV' AND 'KELDYSH' ON PACIFIC-INDIAN OCEAN CRUISE

Moscow VODNYY TRANSPORT in Russian 24 May 84 p 4

[Article by B. Filyushkin, candidate of Geographic Sciences, head of the expedition on board the scientific research ship "Dmitriy Mendeleyev" (by radio)]

[Text] Under the command of Captains V. Demin and V. Kaz'min, the scientific ships "Dmitriy Mendeleyev" and "Akademik Mstislav Keldysh" have set out from Vladivostok on another long cruise. On board the ships are scientists and specialists of a major new expedition of the Institute of Oceanology imeni Shirshov. The participants in this expedition will conduct large-scale hydrophysical and other studies, and carry out synchronous observations in line with an expanded program in a number of areas of the Philippine Sea and the Indian and Pacific Oceans. At our disposal are modern Scientific instruments and devices, a "Pisces" deep-sea submersible craft, independent buoys and computer technology. The expedition will last 110 days.

FTD/SNAP
CSO: 1865/213

SHIP 'ISSLEDOVATEL'' STUDIES SOUTH ATLANTIC OCEAN FLOOR

Moscow SOVETSKAYA ROSSIYA in Russian 24 Jun 84 p 6

[Article by S. Mel'nikova (Gelendzhik and Moscow)]

[Excerpt] The scientific research vessel "Issledovatel'" of the
Southern Marine Geology Association has returned to its native shores
after completing a cruise in the South Atlantic. It has been taking part
in a large-scale program of geological-geophysical work lasting many years,
which is being carried out by specialists of the Ministry of Geology and
the USSR Academy of Sciences.

We began our conversation with G. N. Grashkin, head of the cruise that had
just been completed, by asking how the "Issledovatel'" took the ocean waves.

"Normally," said Gennadiy Nikolayevich with a smile.

The ship is like any other at first glance. But a visit to its work areas is
enough to drive the romantic attributes of the sea from one's mind at once.
Instruments that switch on and off quietly and a computer from which a
perforated tape descends silently to the floor are located in these rooms.
All of this equipment together makes up an integrated system called "Mars-2".

"From the technological standpoint, this system combines an onboard geophysi-
cal computer center (two computers) with geophysical-information pickups and
a system for automatically controlling the ship in accordance with a designated
program, using signals from satellites and navigational systems," said
Gennadiy Nikolayevich. "The 'Mars-2' has completely automated all research
and it conducts it around the clock."

The ship has been operating in the South Atlantic region since 1980, taking
part in the long-term program of geological-geophysical work.

Grashkin showed me a map of the ocean floor, on which were represented a
submarine ridge and two basins, the Angola and the Brazilian, on each side.
Studies of areas of such contrasting floor relief make it possible to gain a
better knowledge of the structure of the Earth's interior.

The experiment in which the "Issledovatel'" is taking part is unique in
world oceanology. Its tasks are extremely broad, ranging from theoretical

and basic ones to purely applied ones. The construction of standard models of the ocean floor's crust makes it possible to study features of individual elements of this crust and the Earth's crust as a whole, for example. On the basis of these models, scientists forecast the distribution of deposits of oil, gas and complex ores. Work on appraising potential oil and gas reserves of the Angola Basin has already been completed. This year, the "Issledovatel'" will continue its work in the Brazilian Basin after "crossing" the Mid-Atlantic Ridge.

FTD/SNAP
CSO: 1865/245

RESEARCH SHIP 'KURENTSOV' COMPLETES SOUTH ATLANTIC CRUISE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 23 Jun 84 p 1

[Text] The scientific research vessel "Professor Kurentsov" has returned
to the port of Murmansk following a five-month cruise. Together with repre-
sentatives of the USSR Academy of Sciences' Institute of Earth Physics,
specialists of an arctic marine geological-survey expedition on board this
vessel took part in a unique scientific experiment for studying the Earth's
crust beneath the ocean's waters in the South Atlantic area.

FTD/SNAP
CSO: 1865/245

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RESULTS OF OCEAN-ATMOSPHERE INTERACTION STUDIES IN WEST ATLANTIC

Vilnius KOMSOMOL'SKAYA PRAVDA in Russian 16 Jun 84 p 3

[Excerpt] In the opinion of scientists, a model of ocean-atmosphere inter-
action can be developed which will forecast the weather for periods as long
as a year, for example. The latest major expedition of scientists for the
purpose of gathering information necessary for a future model was sent to the
northwest part of the Atlantic in the fall of last year. This expedition
traveled on board the "Akademik Kurchatov" and the "Vityaz'", scientific
research vessels of the USSR Academy of Sciences. Viktor Neyman, head of
the department of expedition research methods and organization of the USSR
Academy of Sciences' Institute of Oceanology, told about the results of this
expedition, at the request of APN correspondent Andrey Chernoshchek.

"A research program which has been given the name 'Razrezy' (cross-sections)
was proposed by academician Guriy Marchuk. This program calls for regular and
long-term study of large-scale interaction between the ocean and the atmosphere.
This research takes the form of a system for probing the upper layer of the
ocean's waters to certain depths—up to 2,000 meters, for example. Measure-
ments are made of hydrophysical parameters, such as the temperature, density
and salinity of the water and the speed of currents. Hydrochemical measure-
ments are in progress at the same time; the content of dissolved oxygen and
other elements in the water is studied. Scientists also keep the weather
under observation; wind speed, temperature, humidity and the amount of pre-
cipitation are measured from the deck of a ship. Information on the lower
layer of the atmosphere is gathered with the aid of aerological probes. All
of this makes it possible to determine how the ocean interacts with the
atmosphere during a specific moment at a certain point on the planet. A set
of such points permits the construction of a section—a profile of the water
layer and the atmosphere. A series of such sections, when repeated, makes
it possible to trace the dynamics of this interaction over a prolonged period.
Information of this type which has been gathered at different times of the
year can be statistically generalized and incorporated in a mathematical model.

"A Soviet scientific expedition was sent to an area of the Gulf Stream to
gather such information in the fall of last year. The time and place of this
expedition were not chosen at random. Its program called for conducting and
experiment in an energy-active zone of the Gulf Stream north of the Bermuda
Islands. The term 'energy active' is applied to such a zone because the

ocean's effects on processes occurring in the atmosphere are greatest there. And the most active ocean-atmosphere interaction is observed in the autumn-winter period. During the expedition, the scientists had to gather a large amount of data and study, for example, the flow of heat and moisture from the ocean into the atmosphere, fluctuations of the Gulf Stream's axis, and submarine eddies formed by these fluctuations. These eddies are an important element of the ocean's dynamics in the area under study.

"On the basis of reports on materials gathered which have been received from the vessels, it can be said that the expedition was carried out successfully. All of the tasks it was assigned were accomplished. An observation of submarine eddies became an important feature of this work. A layer of ocean was found to be permeated from top to bottom with eddies whose waters were colder than the waters surrounding them. The fact that two vessels took part in the expedition simultaneously had a positive effect on its results."

FTD/SNAP
CSO: 1865/223

NON-MAGNETIC VESSEL 'ZARYA' BEGINS ATLANTIC-MEDITERRANEAN CRUISES

Moscow VODNYY TRANSPORT in Russian 19 Jun 84 p 4

[Article by V. Martyshin]

[Text] The scientific research schooner "Zarya" has left Leningrad on its latest cruise. This trip of the world's only non-magnetic vessel is an anniversary one, its 25th. This time, the Canary Islands region of the Atlantic Ocean and the Mediterranean Sea will be the vessel's areas of work.

"The first of these work areas is interesting by virtue of the fact that the most powerful slow changes of magnetic fields take place there," related A. Karasik, head of the department of marine geomagnetic research of the Leningrad branch of the USSR Academy of Sciences' Institute of Earth Magnetism, the Ionosphere and the Propagation of Radio Waves.

The Mediterranean Sea is the second region of work. The scientists were attracted to it by magnetic anomalies and the geological structure of its seabed. These studies will help to determine the correctness of a hypothesis regarding the origin of this water basin.

FTD/SNAP
CSO: 1865/223

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FEATURES, RESEARCH PLANS OF NEW SCIENTIFIC SHIP 'ARNOL'D VEYMER'

FAVORSKAYA, A.

[Abstract] The article records a conversation with Professor Ayn Aytsam, head of the Baltic Sea Department of the Estonian Academy of Sciences' Institute of Thermal Physics and Electrophysics, regarding features of the "Arnol'd Veymer", a new scientific research vessel of this institute. This vessel was specially designed to the Institute's orders and built at a Finnish shipyard, and its maiden cruise is scheduled for June of this year.

The "Arnol'd Veymer" is characterized as a modernized successor to the research vessel "Ayu-Dag", which is to be taken out of service in approximately a year, according to Aytsam. The "Arnol'd Veymer" is said to possess greater physical capabilities than its predecessor. Aytsam explained that these vessels are intended for research of relationships between pollution and the dynamics and condition of sea water. The Thermal-Physics Institute is collaborating in this work with a number of major Soviet and foreign institutes, including the Institute of Marine Research in Kiel, West Germany. The "Arnol'd Veymer" is equipped with special data gathering and processing technology, including high-speed computers, for such research. Data gathered during expeditions of the vessel will be used in mathematical modeling of the Baltic Sea as an integral ecosystem, for example.

The "Arnol'd Veymer" is said to incorporate a number of conveniences for researchers, including special doors through which measuring instruments can be set out. Onboard laboratories are arranged around these doors, which open automatically. The vessel will also carry a computer system with a bank of data on the sea. This system will be in constant communication with an onshore system at the Thermal-Physics Institute. Together, they will make up a comprehensive system for controlling experiments which is expected to raise research to a new level. Specialists at onshore facilities will receive data which have been processed in advance on board the vessel, for example.

Aytsam mentioned in conclusion that his institute expects to use the "Arnol'd Veymer" also in research which is being conducted within the

foreign scientists on methods for an upcoming experiment in the northwest part of the Atlantic Ocean.

A photograph is given showing the "Arnol'd Veymer" on the water.

FTD/SNAP
CSO: 1865/162

THEORY OF STRUCTURE OF WAVE FRONTS IN DISPERSIVE MEDIA WITH DISSIPATION

BARENBLATT, G. I. and SHAPIRO, G. I., Institute of Oceanology, USSR Academy
of Sciences

[Abstract] The Korteweg-de Vries-Burgers equation was used in examining the
structure of wave fronts in dispersive media characterized by weak dis-
sipation. The distribution of the characteristics of movement across such
fronts has an oscillatory character. In a case when the number of oscilla-
tions in the front is large the authors derive a nonlinear equation of the
Burgers type for spatially smoothed parameters. It is then shown that the
effective viscosity entering into this equation can exceed the actual value.
Within the framework of a semi-empirical approach it was then possible to
propose formulas for effective viscosity. A comparison of the initial
(unsmoothed) equation in both stationary and nonstationary stages is then
made with the results of numerical and analytical computations. A simple
expression ((27) in the article) is proposed as a constructive relation-
ship between the characteristics of small-scale (high-frequency) and macro-
scale characteristics of the wave front. Such a relationship makes it
possible to evaluate (with an accuracy to ~50%. entirely satisfactory for
the purpose) the small-scale characteristics of dispersion fronts on the
basis of measurements made with inadequate space or time resolution. The
semi-empirical scheme proposed for describing a dispersion wave front and
the adopted closure formulas make it possible to evaluate the order of
magnitude of the coefficient of turbulent viscosity and to describe the
smoothed characteristics of a front on the basis of an equation simpler
than the initial equation and to establish a relationship between the
small- and macroscale characteristics of a front. Figures 4;
references 11: 9 Russian, 2 Western.
[132-5303]

EVOLUTION OF INITIAL DISTURBANCES OF CONTINUOUSLY STRATIFIED FLUID

DOTSENKO, S. F., Marine Hydrophysical Institute, Ukrainian SSR Academy of
Sciences

[Abstract] There have been virtually no studies of the dynamics of spatial
inertial disturbances of a continously stratified rotating fluid with N $\neq$
const. This article gives an analysis of evolution of anomalies of the
density field for the mean distribution of the Brunt-Väisälä frequency in
the POLYMODE test area region. Since the Coriolis parameter is assumed to
be constant, the Rossby wave is excluded from consideration. The influence
of the β-effect requires special study and therefore is also neglected here
(the β-effect seems to be important in describing evolution of baroclinic
disturbances in the ocean at synoptic scales of movement). The problem is
examined in the following formulation: a study is made of an ideal incom-
pressible fluid with the depth H rotating at a constant angular velocity
relative to the vertical z-axis, the fluid layer being unbounded in the
horizontal coordinates x and y. The Coriolis parameter l = const > 0.
Fluid density in an undisturbed state ρ_0 is a smooth function of the z-
coordinate and the Brunt-Väisälä frequency $N(z) > l$. With $t \leq 0$ the fluid
locally loses its state of hydrostatic equilibrium. Its motion is studied
with $t > 0$. An asymptotic   alysis was made of the unsteady waves which
develop. An analytical-numerical procedure is proposed for studying the
evolution of axisymmetric anomalies of the density field in a continuously
stratified fluid. It is shown that the energy of barotropic disturbances
in the ocean is virtually completely expended on the generation of the
rapidly attenuating surface wave. For the lower baroclinic mode the energy
of the geostrophic formation is less than, equal to or greater than the
energy transported by the waves if $L \lessgtr 125$ km. With small L there is a
predominance of transfer of energy to the waves. Thellarge number of modes
introduces a substantial contribution to the wave field with small L. With
L > 125 km the eddy formation mechanism predominates and the wave field is
determined by the first baroclinic mode. This result agrees with the con-
clusion drawn earlier that the lower modes made a dominant contribution to
the mesoscale variability of fields in the POLYMODE test area. Figures 3;
tables 1; references 20: 17 Russian, 3 Western.
[132-5303]

EFFECT OF STRONG AMPLITUDE MODULATION OF SURFACE WAVES BY NONSTATIONARY
INTERNAL WAVE

DULOV, V. A. and KUDRYAVTSEV, V. N., Marine Hydrophysical Institute,
Ukrainian SSR Academy of Sciences

[Abstract] A study was made of the interaction between surface waves and
internal waves because these interactions determine the geometry of the
free surface. It is shown that nonstationary internal waves can lead to
strong amplitude modulation of surface waves in an essentially nonresonance
case. First, in the geometrical optics approximation, the effect of a non-
stationary internal wave on the parameters of surface waves is investigated.
Then model examples are presented which make clear that an essentially non-
stationary internal wave leads to the development of intensive amplitude
modulations of a surface wave with a group velocity differing considerably
from the phase velocity of the internal wave. An analysis of the critical
time of interaction as a function of the parameters of surface and internal
waves is presented. The observed effect also exists in the long-wave region
of the surface waves with group velocities far from resonance for which the
adiabatic interaction approximation is primarily applicable. Figures 2;
references 2: 1 Russian, 1 Western.
[132-5303]

TRANSIENT GENERATION OF INTERNAL WAVES BY MOVING MASS SOURCE

TEODOROVICH, E. V., Institute of Applied Mathematics, USSR Academy of Sciences

[Abstract] The energy losses on the transient generation of internal gravity
waves with intersection of the interface of two homogeneous fluids by a
uniformly moving mass source simulating a moving body are computed. The
article gives the derivation of the initial equations, followed by a discus-
sion of the energy losses in transient generation, the characteristics of
the hydrodynamic field and an example of computations. The result can be
used in evaluating the influence of the fine thermohaline structure observed
in the ocean on the generation of internal waves in which layers of strongly
mixed quasihomogeneous fluid alternate with narrow interlayers with great
density gradients. When several interlayers are present the energy losses
in transient generation of internal waves during vertical movement of the
body can be determined approximately as the sum of losses in individual
interlayers (the interference of internal waves of different interlayers
is neglected). Then the mean energy losses per unit path length can be
determined. In the example cited the scales $L = 10^3$ m, $\ell = 10$ m are used
(ℓ is the distance between interlayers). Thus the energy losses in a
uniformly stratified and layered-stratified medium will be of the same order
of magnitude for a body with the characteristic transverse dimensions a
about 0.1 m (the size of the research probe). But with a decrease in the
characteristic size of the body the energy losses in the case of a layered
stratification will become greater than the corresponding value in the case
of a uniform stratification. References 11: 10 Russian, 1 Western.
[132-5303]

SHIPBOARD REMOTE MICROWAVE MEASUREMENTS OF INTERNAL WAVES

VESELOV, V. M., DAVYDOV, A. A., SKACHKOV, V. A., CHERNYY, I. V. and
VOLYAK, K. I., Space Research Institute, USSR Academy of Sciences;
Physics Institute USSR Academy of Sciences

[Abstract] The article gives some results of simultaneous observation of
the surface emergence of well-developed internal waves by radiophysical
apparatus from aboard a ship and their measurement by contact sensors
carried out in the Indian Ocean on the 26th cruise of the "Dmitriy
Mendeleyev." One of the principal results of this expedition was the

discovery of a broad field of well-developed high-frequency internal waves
near the Mascarene Ridge. The measurements revealed that particularly power-
ful internal waves were generated by tidal currents on the eastern slopes of
the ridge, propagating eastward into a region with typically oceanic depths.
The contact sensors used repeatedly registered trains of internal waves
frequently attaining amplitudes of several tens of meters. The radio-
physical complex included active and passive instruments operating in the
centimeter and decimeter ranges. The radiobrightness temperature of the
ocean surface and the level of scattering of radio waves by it had con-
siderable differences over a packet of internal waves and were in phase with
them. Simple hydrodynamic concepts are used in interpreting the results
within the framework of existing models of the emission and scattering of
radio waves by the sea surface. The study revealed that remote passive and
active radiophysical instruments operating in the cm and dm ranges can
reliably register currents induced at the ocean surface by internal waves
and the temporal and spatial parameters of internal waves can thereby be
' measured. Figures 5; references 15: 8 Russian, 7 Western.
[132-5303]

NONLINEAR THERMAL WAVES ATTRIBUTABLE TO INFLUENCE OF HORIZONTAL SOURCES OF
HEAT-RELEASING ADMIXTURE IN NEUTRALLY STRATIFIED MEDIUM

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[Abstract] Turbulent mixing during the development of Rayleigh-Taylor
instability was investigated earlier within the framework of similarity
theory and semi-empirical turbulence theory. The author now examines a
similar one-dimensional problem for a case when there is a plane layer of
a weightless heat-releasing admixture in a fluid which initially was
neutrally stratified. It is assumed that a fluid fills an infinite
region $-\infty < z < \infty$ (the z-axis is directed opposite gravity). Some quantity
M (per unit area) of heat-releasing admixture is introduced instantaneously
at the level $z = 0$ at the time $t = 0$. If the medium is initially stratified
neutrally in the region $z > 0$, turbulent convection begins in this region
as a result of the heat release associated with the admixture. It will
transport upward the heat, admixture and heat release. This transport is
described by the coefficient of turbulent exchange K. Assuming that the
heat source associated with the admixture is proportional to its partial
density, a system of equations for the transfer of heat and admixture can be
written for a one-dimensional case. The examination oan be limited to the
region $z \geq 0$, requiring that the turbulent fluxes become equal to zero at
the level $z = 0$; with greater z values far from the source of the admixture
the fluxes must also become equal to zero. This formulation of the problem
is quite similar to the "strong heat wave" problems defined by

G. I. Barenblatt. The problem is self-similar. The length scale L can be obtained from the parameters of the problem and time. The turbulence scale ℓ and the thickness of the turbulent (convective) region z_* must be proportional to L. Then a solution is found from dimensionality and similarity considerations. References 9: 8 Russian, 1 Western.
[132-5303]

STATIONARY AND OSCILLATORY CONVECTION REGIMES IN ROTATING FLUID

KAS'YANOV, S. Yu., Institute of Biomedical Problems

[Abstract] V. V. Shuleykin was the first to report on the phenomenon of thermopressure seiches in the atmosphere arising over the nonuniformly heated surface of the ocean and continent. An analogue of seiches of this type is the autooscillations reported by V. I. Chuprynin in DOKLADY AN SSSR, Vol 229, No 1, pp 63-66, 1976. These, together with the peculiarities of transient regimes, are explained in this article, which describes a mathematical model of three-dimensional convection. Movement of a Boussinesq fluid in a cylindrical vessel is examined. This fluid is initially uniformly heated and rotates as a unified solid. Fixed heat "sources" and "sinks" are distributed through the volume of the fluid; this corresponds to the heating of one part of the lower layer of fluid and cooling of the diametrically opposite part of the lower layer of fluid. In simplifying the solution the influence of the near-wall boundary layers is neglected. These and other conditions make it possible to find the vector base functions for the Galerkin method by the method of separation of variables and thereby substantially simplify solution of the problem. In solving the problem the system of equations in the Boussinesq approximation is replaced by a system of ordinary differential equations whose coefficients are formed and stored in an electronic computer. The model makes use of the first 6 base functions (24 for velocity and 12 for temperature), which corresponds to an examination of the first two wave numbers for each of the three space coordinates. The computations were made with $Pr = 7$, $H = 0.4$ corresponding to water and the geometry of the vessel in the experiment. Examples of the observed autooscillations are described and discussed. These autooscillations, detected experimentally and in the mathematical model, are also observed in nature in the form of thermopressure seiches. Figures 2; references: 4 Russian.
[132-5303]

INCREASE IN AMPLITUDE OF LONG WAVE NEAR VERTICAL WALL

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[Abstract] In the planning of structures in ports and harbors it is im-
portant to estimate the maximum water level near a vertical wall exposed to
the influence of oncoming sea waves. Since the depth in the shore zone is
insignificant, the nonlinear effects here are important. A precise solution
of the problem of wave reflection from a vertical wall is known only for a
shock wave; for waves with a smooth profile there are approximate solutions
based on a two-soliton model. In this article the author obtains a precise
solution for the maximum water level near a vertical wall when a long wave
of arbitrary height is incident on it. In solving the problem the point of
departure is nonlinear equations for shallow water which are then rewritten
in Riemann variables. This gives two families of characteristic curves which
when represented diagrammatically make it possible to determine the region
of interaction between an incident wave and a reflected wave near a vertical
wall. Since the values of the invariants remain constant on the character-
istics, the wave interaction effect is manifested only in the appearance
of additional delays in the arrival time of waves with a definite value of
the Riemann invariant. After additional steps it is possible to derive a
formula for the maximum level (height). Figures 2; references 6:
3 Russian, 3 Western.
[132-5303]

PHYSICAL PROPERTIES OF SEDIMENTS IN NORTHWESTERN PART OF PACIFIC OCEAN

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[Abstract] Data on the speed of sound, density and porosity of sediments
covering the floor of the Pacific Ocean to the east of the Kuril Islands
and Kamchatka reveal that these parameters are dependent on the genetic
type of sediment and its granulometric composition. The authors have
defined three provinces in the studied area: 1) an island and continental
slopes and oceanward edge of trench, 2) an area of major rises, 3) an abyssal

basin. The studied pelitic and siltypelitic sediments are characterized by
lower velocities than in sea water of normal salinity. The presence of a
low-velocity layer (acoustic channel) in the surface layer of bottom sediments
evidently must be taken into account when carrying out sea seismic work and
in the interpretation of the results. The genetic type of sediments and
granulometric composition are the main factors exerting an influence on the
velocity of sound propagation in unconsolidated sediments, porosity and
density. Accordingly, it is possible to predict the physical properties of
sediments using the results of lithological studies. The presence of horizons
enriched with pyroclastic material and pumice in the surface 3-m layer of
hemipelagic sediments and clays of the transitional type in the northwestern
part of the Pacific Ocean, their persistence in strike and increased speeds
of sound values within the limits of these horizons in some cases make it
possible to correlate sections at individual stations, separated by a dis-
tance as great as 550-650 km, by physical methods and to postulate the
presence of an acoustic quasi-anisotropy of sediments in this zone. Figures 4;
table 1; references 6: 5 Russian, 1 Western.
[118-5303]

HYDROMAGNETIC STUDIES OF UNDERWATER VOLCANIC ZONES IN MARGINAL SEAS OF
PACIFIC OCEAN (IN EXAMPLE OF NEW GUINEA AND SOUTH CHINA SEAS)

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[Abstract] The article gives the results of hydromagnetic research carried
out for study of regions of manifestation of underwater volcanism in the
New Guinea and South China marginal seas. The authors outline the possi-
bilities of the method for defining (mapping) volcanic zones, study of
their structure and individual aspects of the history of geological
development and quantitative estimates of the age and volumes of the ejected
material. Investigations in the New Guinea Sea revealed a zone (hypothetical-
ly a rift zone) of underwater fissure outpourings of basalts. Data from a
magnetic survey were used in estimating the volumes of outpouring lavas;
the approximate position of fissures extruding magma was determined; the age
and sequence of rock formation were estimated. On the shelf of the South
China Sea there is an areal volcanic zone with small (up to 100 m in height)
volcanoes. The regionalization of the volcanic zone on the basis of magnetic
anomalies made it possible to estimate the volume of volcanites and their
intrusive analogues in the upper 500-m layer in a section of about 20 km^3
(this is the minimum figures; a survey of the required detail covered not
more than 25% of the area of the volcanic zone). The forms of manifestation
of modern underwater volcanism for the studied areas of the New Guinea and

South China Seas are substantially different. With respect to the scales of manifestation and volumes of eruptive material the underwater volcanic activity in the New Guinea Sea is at least an order of magnitude greater than in the South China Sea. Figures 4; table 1; references 11: 7 Russian, 4 Western.
[118-5303]

COMPARATIVE CHARACTERISTICS OF DERYUGIN AND TINRO DEPRESSIONS IN SEA OF OKHOTSK

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[Abstract] The Deryugin and TINRO depressions are situated in diametrically opposite parts of the Sea of Okhotsk. Several reflected waves-common deep point profiles were run through these depressions in combination with gravi-magnetic and bathymetric measurements. In combination with data from geological-geophysical work in adjacent water areas of northeastern Sakhalin and Western Kamchatka, this made it possible to ascertain the structure and development of these depressions. The depressions are clearly expressed in bottom relief (Fig. 1 shows sections through these two megadepressions). The major negative structures with which the modern depressions are associated much resemble foredeeps. Their outer sides are characterized by sharply re-duced thicknesses are variable, but an order of magnitude greater, this being associated with an orogenic rise of adjacent territories in Western Kamchatka and Sakhalin in the Late Cenozoic. However, the Precenozoic history of the entire region is unknown. The absence of Paleocene-Early Oligocene deposits and active manifestation of Late Cenozoic cosedimentation tectonic processes in the first of them give basis for assuming that the Deryugin megadepression at present is possibly experiencing the early stage in the development of the TINRO megadepression. These megadepressions probably developed together with contiguous Cenozoic folded-block systems. The fundamental difference is that the former developed under dilatational conditions and the latter under compressive conditions. Figures 2; references: 8 Russian.
[118-5303]

SOME CHARACTERISTICS OF FRONTAL EDDIES OF EAST AUSTRALIAN CURRENT

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[Abstract] The East Australian Current has become famous for the large
frontal anticyclonic eddies which are generated by it. The meandering of
this current and the separation of anticyclonic eddies from it is very
similar to the process generating anticyclonic rings in the Gulf Stream
and Kuroshio, although in their structure the rings of the East Australian
Current have little in common with the latter. The authors have undertaken
a study of the physical nature of this phenomenon. A comparison is made of
typical T,S-curves of waters in the frontal zones of the Gulf Stream and
Kuroshio and typical T,S-curves of waters of the Tasman front and the
East Australian Current and this is used in an analysis of characteristics
of the thermohaline structure of anticyclonic rings formed by this current.
Australian data on the evolution of such rings over the course of a pro-
longed time are used in an examination of isothermal cores in them with the
participation of winter convective mixing. It is not only winter mixing
which is involved in core formation; a role is also played by a poloidal cir-
culation whose radial-convergent branches at intermediate horizons are of an
isopycnic nature. The radial velocities can attain $1 \ cm \cdot sec^{-1}$. It is shown
that isothermal cores with a volume of $10^{12} \ m^3$ could be formed in anticyclonic
rings due solely to radial-convergent isopycnic movements with such veloci-
ties without participation of winter convection in about 10 days. The
authors fully examine the characteristics of the fine thermohaline structure
in the eddies of this current associated with the strictly baroclinic nature
of the front on which they arise. Figures 7; references 16: 4 Russian,
12 Western.
[139-5303]

YEAR-TO-YEAR VARIABILITY OF LOMONOSOV CURRENT

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[Abstract] Observational data from the GATE and FGGE experiments were used
in a comparison of characteristics of the Lomonosov Current at the meridian
$23°30'W$ in the summers of 1974 and 1979. The data in Table 1 characterize

the effect of the Trade Winds on the ocean surface, the zonal pressure gradient
along the equator forming during this time and the easterly transport of
waters by the current caused by these factors. An almost 40% increase in the
summer discharge of the Lomonosov Current from 1974 to 1979 is evidence of
the considerable year-to-year variability of intensity of the equatorial sub-
surface countercurrent, by a factor of more than 1.5 exceeding the earlier
detected seasonal variability. The increase in the discharge of this current
in the summer of 1979 in comparison with 1974 is in qualitative agreement
with some increase in the westerly zonal component of wind shearing stress
and the zonal pressure gradient. The observational data on currents and hydro-
logical observations on meridional profiles were used in evaluating the mean
summer characteristics of the core of maximum velocities and the salinity
core of the Lomonosov Current, as indicated in Table 2. The observed differ-
ences in characteristics of the Lomonosov Current are so great that the
question arises as to whether the data for 1974 or 1979 are more representa-
tive. The data summarized in Table 3 answer this question: in the summer
of 1974 the state of the atmosphere and ocean, with respect to a whole series
of indices, is extremely close the mean multiyear norm, whereas in the summer
of 1979 the dynamic activity of the atmosphere and ocean was increased.
Tables 3; references 5: 3 Russian, 2 Western.
[139-5303]

FORMATION OF INTERMEDIATE WATERS IN MEDITERRANEAN SEA

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[Abstract] A highly saline intermediate (Levantian) water mass, constituting
about 26% of the water volume in the Mediterranean Sea, as a result of water
exchange through the Bosphorus and Strait of Gibraltar, exerts an important
effect on the thermohaline structure of the Black Sea and the Atlantic Ocean.
It has been postulated that there is a narrowly local formation of inter-
mediate waters in the period of maximum cooling of the surface layer (in late
February-early March). This hypothesis was checked during the first half
of March 1977 by running a uniform hydrological survey of the entire
eastern basin. This was supplemented by additional research between Crete and
Cyprus in mid-February 1982. On the basis of these investigations it was
concluded that the principal centers of formation of highly saline and warm
intermediate waters are the centers of the more northerly cyclonic circula-
tions where in winter there are favorable climatic conditions and some
oceanological conditions for the development of convective mixing to depths
of 150-200 m. The heavy surface waters mixing here then slip along the
dome of the persisting pycnocline to depths of 300-400 m and give rise to an

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intermediate water mass. In most cases the spatial and temporal scales of these phenomena are small (several tens of miles and several days of severe winter conditions during the period of maximum cooling of the surface layer in late February-early March). Another remarkable peculiarity of Levantian waters at the intermediate horizons is that they are disseminated through the Mediterranean Sea and are renewed very slowly, the latter process requiring about 26 years. Figures 3; references 10: 7 Russian, 3 Western.
[139-5303]

DETERMINING INITIAL T,S INDICES OF MEDITERRANEAN WATERS

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[Abstract] Mediterranean waters entering the Atlantic Ocean through the Strait of Gibraltar exert an enormous influence on the hydrological regime of intermediate waters. These waters are traced enormous distances from the source of formation as far as the Sargasso Sea. In measurements of T,S characteristics of Mediterranean waters in different regions of the Atlantic it must be taken into account that these waters are considerably transformed, the degree of transformation being dependent primarily on the distance of the studied region from the source of these waters. It is clear that the initial T,S indices of Mediterranean waters must be known for evaluating the degree of transformation. The waters passing through the Strait of Gibraltar are formed in the eastern part of the Mediterranean Sea (Levantian waters). In this region of the Mediterranean Sea winter convection in February-March is propagated to depths of 400-600 m with the formation of the Levantian water mass with mean temperature and salinity values in the layer 0-400 m of $T°C = 14.5$ and $S°/oo = 38.85$. The initial characteristics of these waters after reaching the western Mediterranean were $T°C = 13.9$ and $S = 38.7$. It is these values which are proposed as the required initial indices when studying Mediterranean waters after their passage through the Strait of Gibraltar. Data are presented clearly suggesting the formation of a double maximum of Mediterranean waters in the Atlantic Ocean. Figures 2; tables 2; references 15: 5 Russian, 10 Western.
[139-5303]

TIDAL OSCILLATIONS ON SAKHALIN ISLAND SHELF

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[Abstract] Meausrements of currents made on the northeast shelf of Sakhalin
Island show that in the high latitudes shelf waves exert an influence on the
nature of oscillations of all diurnal tidal harmonics. The breakdown of
the wave field of tides into individual components makes it possible to
formulate a simple three-dimensional model and to explain the characteristics
of tidal dynamics in this particular region. The model was based on observa-
tions of currents made by Japanese specialists in July-September 1976; data
for three stations were used. The tides in the Sea of Okhotsk are primarily
induced; the coast in the region of the stations is close to linear. The
data show that a Kelvin wave and the first mode of shelf waves participate
in formation of the diurnal tidal harmonics; the first mode has two different
wave numbers, the first of which corresponds to a negative group velocity,
whereas the second corresponds to a positive group velocity. Level oscilla-
tions with an amplitude of 10 cm correspond to current velocities of 0.9,
27 and 67 cm/sec for the Kelvin wave, the first and second shelf waves
respectively. The very limited volume of observational data of levels on
the northeastern shores of Sakhalin Island makes it difficult to evaluate
the region of applicability of the formulated model. Nevertheless, the good
agreement of computed and observed values of the harmonic constants confirms
correctness of the model for the considered region and it is clear that it
can be used in evaluating tidal level oscillations. Figures 3; tables 2;
references 12: 8 Russian, 4 Western.
[139-5303]

INDUCED LEVEL OSCILLATIONS ALONG SHORES OF KURIL ARC IN SYNOPTIC FREQUENCY
RANGE

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[Abstract] This article represents a continuation of an earlier article
by O. N. Likhacheva, et al. (IZV. AN SSSR: FIZIKA ATMOSFERY I OKEANA,
Vol 17, No 5, pp 513-520, 1981). Here, in studying the reaction of the
ocean level to atmospheric pressure and wind, on the basis of a statistical

analysis use is made of series with a duration of 1 year or more, making it possible to obtain reliable estimates in the synoptic frequency range and to investigate the low-frequency part of the spectral characteristics. Emphasis is on induced oscillations of ocean level on the shelf of the Kuril arc associated with atmospheric cyclonic activity. Observational data for different points are used, including those situated on the Sea of Okhotsk side, this enabling the author to draw conclusions concerning the influence of topographic characteristics of the observation site on oscillations of ocean level under the influence of meteorological disturbances. In the analysis use was made of series of observations of ocean level with a discreteness of 1 hour, pressure and wind direction and velocity with a discreteness of 3 hours at a series of stations. The periodic (tidal) and hydrostatic components were subtracted from the ocean level values in order to obtain ocean response to the passage of cyclones. Synchronous series were obtained for the level, pressure and wind. The analysis of annual series of hydrometeorological information revealed that the response of ocean level to atmospheric disturbances is determined by the following. 1) The effect of varying atmospheric pressure, which conforms to the hydrostatic law. The principal contribution to pressure falls in the frequency range 0.03-0.7 cycle/day. 2) The passage of cyclones and typhoons along the Kuril arc, which excite ocean level waves propagating to the northeast at frequencies 0.14, 0.22 and 0.35 cycle/day. 3) Long-period wind stress changes which excite level oscillations at frequencies less than 0.1 cycle/day. With an increase in sea depth the lower-frequency wind stress components play a role. Figures 7; table 1; references 11: 7 Russian, 4 Western. [139-5303]

SPATIAL DISTRIBUTION OF ADVECTIVE HEAT INFLUXES IN ATMOSPHERE OVER NORTHERN HEMISPHERE AND ITS RELATIONSHIP TO HEAT INFLUXES FROM OCEAN

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[Abstract] The authors have analyzed the spatial distribution of advective heat influxes in the atmosphere over the northern hemisphere on the basis of aeroclimatic data and its relationship to heat exchange between the atmosphere and ocean. As a point of departure, a formula is written for the heat influx due to macroscale atmospheric movements in a unit air column with a height Z. The parameter Z represents the height of 500-mb isobaric surface, selected because the influence of the ocean on the atmospheric thermopressure field is reflected most clearly in the lower part of the troposphere to the height of the 500-mb surface and above this level computation of the divergence of heat fluxes is very sensitive to errors in initial data. The terms of this equation were computed for 16 test areas in the North Atlantic formed by shipboard, island and on-shore

stations and "stations" representing the centers of 10° squares to which all
observational data available within the square are assigned. It is shown that
the heat influxes due to macroscale atmospheric processes in the lower and
middle troposphere, computed on the basis of climatic data for test areas
with linear dimensions of about 1,000 km, are almost completely determined
by the advection of "apparent" and "latent" heat. Figures 1 and 2 are maps
of the February distribution of advective influxes of "apparent" and
"latent" heat. In the first approximation the patterns of distribution of
these influxes coincide. There is a close negative correlation between
advective heat influxes and turbulent heat exchange between the ocean and
atmosphere in winter. These findings indicate the need for taking heat
advection into account when making computations of the heat balance and in
preparing a climatic description of the North Atlantic. Figures 3;
references 20: 14 Russian, 6 Western.
[139-5303]

WIND INFLUENCE ON CURRENTS AT RIVER MOUTHS

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Academy of Sciences, Moscow; Moscow State University imeni M. V. Lomonosov

[Abstract] Observational data obtained at river mouths by direct measure-
ments and remote methods for studying the earth from space have shownthat
the wind plays an important role in the dynamics of river mouths. However,
the influence of the wind is usually not taken into account in the theoretical
modeling of currents at river mouths. This phenomenon is investigated using
the theory of currents in a well-mixed river mouth described by S. A. Arsen'yev
in VODNYYE RESURSY, No 3, pp 144-153, 1983. The authors here examine a mouth
in the form of a channel with a rectangular section protruding into the sea,
a situation such as is observed at the mouths of the Volga, Ural and
Mississippi Rivers. The spatial variability of the wind field is neglected;
the interaction of large rivers with the ocean is not examined; the spatial
variability of depth is neglected. Formulas are derived which constitute
a solution of the problem. It is shown that the influence of the wind on
current velocity at the mouth is determined by the ratio of the amplitudes
of the velocities of the wind and runoff currents at the water surface.
If this ratio is less than unity there is a predominance of runoff currents;
otherwise the principal role is played by wind currents. The influence of
wind on currents at river mouths is of great practical importance. The
bottom currents excited by the wind exert a strong influence on the
capacity of the mouth to retain wastes or eject them into the sea and the
effect of these currents must be taken into account when conducting many
types of work at river mouths. Figures 4; references 21: 6 Russian,
15 Western.
[139-5303]

PROCESSES OF DESTRUCTION OF PETROLEUM AGGREGATES AT SEA SURFACE

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[Abstract] About 5-10% of the total quantity of petroleum which reaches the
sea surface forms petroleum aggregates or lumps. The processes of destruction
of artificially formed lumps were investigated over a 1-year period in the
laboratory and over a 6-month period in Sevastopol Bay. The rate of de-
struction of these lumps has been unknown, but they appear to be the most
stable form of petroleum pollution. An earlier study (M. P. Nesterova,
et al., OKEANOLOGIYA, Vol 23, No 6, pp 978-983, 1983) described the method
for conducting experiments for study of artificial petroleum lumps and
described the dynamics of the principal physicochemical properties of lumps;
this article is therefore limited to a description of the processes of
destruction of petroleum lumps on the basis of data from gas chromatography.
Quantitative estimates of the intensity of weathering of the petroleum
substrate of these lumps were made using coefficients computed from the
gas chromatograms. These data revealed that the destruction of petroleum
lumps floating in the hyponeustal zone of the sea transpires exceedingly
slowly (their half-life is evidently many years). The principal factor
responsible for the destruction of "fresh" lumps over the course of at
least 6 months is the evaporation of volatile hydrocarbons; this process
transpires most intensively during the first month and then slows down
considerably. Biochemical oxidation occurs only at the surface of the
lumps and therefore is not of great importance; microbial oxidation occurs
only at their surface. The possibility of determining the age of petroleum
lumps floating at the sea surface is discussed. Figures 1; tables 2;
references 18: 12 Russian, 6 Western.
[139-5303]

DEPENDENCE OF CRUSTAL STRUCTURE OF EASTERN PACIFIC OCEAN ON ITS AGE

KUZ'MIN, P. N., Institute of Oceanology imeni P. P. Shirshov, USSR Academy
of Sciences, Moscow

[Abstract] The article gives the results of a study of the age dependence
of seismic parameters of the crust for tectonically homogeneous structures in

the eastern part of the Pacific Ocean (abyssal basins and conjugate sectors of the East Pacific Ocean Rise). The analysis was based on published data and original data collected on expeditions of the Institute of Oceanology. Figure 1 is a map of 350 deep seismic sounding profiles, data from which were used in this study. The following seismic parameters characterizing crustal structure were examined: velocity of seismic waves at the surface of the acoustic basement ("second" layer), wave velocities in individual layers of the crust and at the top of the mantle, thicknesses of the "second" and "third" layers and averaged parameters--crustal thickness nad mean velocity of waves in the crust. Four time zones are discriminated for the purposes of this study: 0-20, 20-40, 40-65 and 65-100 million years. It was found that there is a cyclicity in the change of averaged seismic parameters with age. In particular, the thickness of the "third" layer and to a lesser degree the velocity of seismic waves in the "third" and "second" layers experience a periodic inversion from zone to zone. It is postulated that these and other changes are determined by two groups of factors: genetic and evolutionary. The first group includes those factors which were operative at the time of crustal formation and which caused cyclic changes in thickness of the crust, thickness of the "third" layer, velocities of seismic waves in the crust and at the top of the mantle. The second group includes those factors which affected the crust during the entire time of its existence: underwater weathering, compaction, metamorphism and others. The duration of a cycle is about 50 million years. The author compares the dependence of seismic parameters on age with data on intraoceanic magmatism and data on continental tectogenesis. Figures 5; tables 2; references 21: 11 Russian, 10 Western.
[139-5303]

STRUCTURE OF OCEAN FLOOR IN RELATION TO CONDITIONS FOR FORMATION OF LITHOSPHERE

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[Abstract] By the mid-1970's it had been concluded that the topography of the ocean floor is determined by the process of formation of lithospheric plates due to the crystallization of mantle matter during their spreading away from a rift zone and is dependent on such factors as a change in the parameters of mantle matter and dynamic processes in the mantle. It is these concepts which served as a basis for this study. A detailed study was made of 42 bathymetric profiles intersecting the mid-oceanic ridges of the Atlantic and Pacific Oceans with allowance for data from continuous seismic profiling and also petrochemical and dynamic processes in the mantle. The profiles selected were those oriented perpendicularly to a rift, not

passing through major transformed faults, seamounts and volcanic rises.
A map of the axes of magnetic anomalies was used in determining the age of the
lithosphere. The analysis revealed that mid-oceanic ridges can be classi-
fied on the basis of the position of phase transition points into three
regions, and on the basis of the age of the second phase transition point
into two types (normal and anomalous). The normal type of ocean is character-
ized by an age of the phase transition points t_α = 20 million years and
t_β = 60 million years. The thickness of the oceanic lithosphere, computed
theoretically, coincides with seismic data for the North Atlantic Ridge,
South Atlantic Ridge, East Pactific Ocean Rise, South Pacific Ocean Rise,
and possibly the western ridges of the Indian Ocean. An anomalous type
is found on the southern flank of the Australian-Antarctic Rise. These
facts and others clearly suggest that dynamic processes in the mantle govern
the topography of the mid-oceanic ridges. Figures 2; table 1;
references 11: 4 Russian, 7 Western.
[139-5303]

VELOCITY OF PROPAGATION OF LONGITUDINAL WAVES IN MATERIAL OF FERROMANGANESE
NODULES

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of Sciences, Moscow

[Abstract] There has been only one previous investigation of the speed of
sound in ferromanganese nodules. Accordingly, the author has investigated
the acoustic resistances of nodules from different regions of the ocean.
The velocities of propagation of longitudinal waves in samples of ferro-
manganese nodules taken from four stations in the Pacific Ocean were
measured. The studied nodules were from three different regions of the
Pacific Ocean with two different types of underlying sediments. In the
experiment a rectangular pulse was fed from a generator to an emitter and
after passing through the sample excited a detector. The pulse arriving at
the detector and the emitted pulse were registered from the screen of an
oscillograph by a camera. The emitter and detector of longitudinal waves
were identical piezoceramic disks and were 46 mm in diameter and 4.5 mm
thick, held in foam plastic holders. The measurement error was ± 50 m/sec.
Prior to measurements the samples were saturated with water; measurements
were made at atmospheric pressure; measurements of density and porosity
of samples were made parallel with measurements of the velocities of
longitudinal waves. The principal results of the measurements are tabulated.
In contrast to the findings of K. D. Smith and K. Sundkvist, lower values
are obtained for the mean velocities. There is an anisotropy of the speed
of sound in the samples; measurements were made in two or three different
directions for a study of this anisotropy. There was no significant

correlation between the velocities of propagation of longitudinal waves, on the one hand, and density, porosity and configuration of the samples, on the other. Figures 2, table 1; references 6: 4 Russian, 2 Western. [139-5303]

DETERMINING IRON AND ZINC IN SEA WATER BY THEIR PRELIMINARY CONCENTRATION IN ELECTRICALLY PRECIPITATED MAGNESIUM HYDROXIDE

ZHMAKA, V. I., KOVARSKIY, N. Ya., BELEN'KIY, V. S. and ANISIMOV, R. I., Chemistry Institute, Far Eastern Scientific Center, USSR Academy of Sciences, Vladivostok

[Abstract] The authors examined the possibility of using electrically precipitated magnesium hydroxide as a concentrator of zinc, iron, copper, cadmium, lead and nickel from sea water and describe the specific concentration method and the results of its comparison with the method of extraction of trace elements using diethyldithiocarbamate and 8-hydroxyquinole in chloroform. The sea water samples were taken from the surface at different points in the northwestern part of the Pacific Ocean using a 3-liter container lowered over the side from the ship's prow on a polyethylene line. The water samples were divided into two parts, one of which was used for the concentration by the extraction method. The time from the moment of taking of the sample to the beginning of concentration did not exceed 20 minutes. The apparatus for joint precipitation of magnesium hydroxide and trace elements from sea water, amde from plastic, consisted of an electrolytic cell, fore pump, container for filtered sea water and containers for the drying of air entering the fore pump and the absorption of the chlorine released during electrolysis by a caustic soda solution. In the example of an analysis of 12 samples of ocean water for zinc, iron, copper, nickel and lead it is shown that the method ensures concentration by a factor of 10^3 and gives results quite consistent with those obtained in extraction concentration by diethyldithiocarbamate and 8-hydroxyquinole in chloroform. The correlation coefficient for the results of the analysis obtained by the compared methods was 0.76-0.87 for zinc, iron and copper with a confidence interval 0.05-0.07. The mean zinc and iron concentrations obtained by these methods differ by not more than 10%. Figure 1; table 1; references: 5 Russian. [139-5303]

TERRESTRIAL GEOPHYSICS

UZBEK SCIENTISTS STAVE OFF DISASTER BY PREDICTING EARTHQUAKES

Moscow MOSCOW NEWS in English 3-10 Jun 84 No 21 p 9

[Article by Fyodor Ovechkin]

[Text] "No solution has yet been found to the problem of reliable prediction of the time, place or force of earthquakes, either in this country or in any other," says Professor Valentin ULOMOV, one of the leading seismologists of Uzbekistan, who is deputy director of the Tashkent Institute of Seismology. "This has been shown by the earthquake which hit Uzbekistan on March 20, and whose epicentre is near the town of Gazli. However, the first successes on this road have already been scored. The research carried out by Uzbek seismologists has proved effective.

"On February 18 and March 13 this year, earthquakes of Force 7 to 8 according to the 12-point scale shook the Pap District in Uzbekistan, wrecking many residential, administrative and industrial buildings. However, no one was killed either in the epicentre or around it. A few hours before the tremors began, the local radio network warned the entire population of the district about the approaching disaster, allowing the people to leave the buildings in time. Casualties there were prevented by scientists from the Tashkent Institute of Seismology who, for nearly twenty years, had been looking for and examining the signs of impending earthquakes.

"In the Pap District minor soil movements of Force 2 to 3 had begun on January 26. An expeditionary group of our Institute immediately left for the vicinity of Pap. They launched geophysical, hydrochemical, geodetic and other types of observation required for monitoring the underground processes. The information they obtained was immediately analyzed and summed up. This allowed us to conclude that a strong earthquake was in the offing. We promptly informed the local government who took immediate steps to ensure the safety of the population. Their measures proved timely. The strong earth tremors confirmed that our forecast had been correct."

Out of the 25 methods recognized worldwide as efficient in forecasting earthquakes, five have been produced by the Tashkent Institute. In 1967, a year after it was set up, Uzbek scientists were the first in the world to discover that over the periods which precede and accompany earthquakes, the chemical and gas composition of the subterranean waters radically change in the zone of

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the epicentre. Among other changes, multiple increases in radon, an inert
gas, are observed in water, which allows timely warnings to be made about the
approaching disaster. The finding of this heretofore unknown natural phenome-
non has been registered as a scientific discovery with the State Committee of
the USSR Council of Ministers for Inventions and Discoveries. This method has
aroused interest and is now used by seismologists not only in the Soviet
Union, but also in the United States, Japan, France, Italy, Mexico and
Yugoslavia.

Barely two years after this discovery, the Tashkent scientists proved that in
the pockets of a future earthquake the strength of the underground electromag-
netic impulses rises sharply. If these changes are registered in time, it be-
comes possible to forecast the tremors two to three days before they strike.

Another method devised in Tashkent warns about an earthquake several months in
advance. It is based on a study of the formation of cracks on the surface of
the ground where an earthquake is coming to a head.

Astrogeodetic and magnetic methods produced by the Institute have also proved
efficient in the prediction of the earthquakes.

In order to raise the efficiency of exploration, the Institute has built
twelve seismic forecast stations in different parts of Uzbekistan. These sta-
tions have installed the most up-to-date instruments to allow prediction of
earthquakes with all the methods now known to science.

A comprehensive approach to seismic research is winning more and more victor-
ies for the scientists. An earthquake broke out in the Alai mountains in
Kirghizia in November 1978. The seismologists from Tashkent had been able to
predict its place, time and strength six hours before the tremors began. This
was an unprecedented success in the history of seismology. Congratulations
came from many countries. The well-known American seismologist Robert Wal-
lace, who was in charge of the geological service in California, wrote in a
cable: You have shown everyone an example of what modern seismology can do.
The results of your research are worthy of the broadest possible
dissemination.

In 1976, the Institute was visited by Professor Jim O'Nil, who is from an
institute which studies the structure of the earth in California in the United
States. He was shown the charts, tables, results of analyses and other papers
which showed that strong tremors could be expected near Bukhara before long.
The professor, who was sceptical of the forecast, went to the ancient Uzbek
city himself. Two days after his arrival in Bukhara, a Force 6 earthquake hit
the city. Having seen for himself that the Uzbek scientists had been correct
in their calculations, the American professor returned to the Uzbek capital a
confirmed supporter of the Tashkent school of seismology. He left an ecstat-
ic entry in the guest book, concluding his remarks by saying that he was
amazed, and that he admired and congratulated his Uzbek colleagues.

Several months ago, a parcel came to the Tashkent Institute of Seismology from
Japan. It contained two issues of the magazine Shizen with large articles by

Professor Hiroshi Wakita from the University of Tokyo. Describing the earth-quake forecasting methods devised in Tashkent, the Japanese scientist stressed their importance and high efficiency. Similar publications have come to the Institute from Yugoslavia, France and other countries.

"Contacts with foreign colleagues are very important to us," says Professor Valentin Ulomov.

CSO: 1852/012

SEISMIC ACTIVITY AND MAXIMUM POSSIBLE EARTHQUAKES IN THE ARMENIAN SSR AND CONTIGUOUS REGIONS

[Article by S. R. Aslanyan, S. S. Korakosyan and S. N. Nazaretyan, Order of the Red Labor Banner Institute of Goephysics and Engineering Seismology, Armenian SSR Academy of Sciences]

[Text] Use of a statistical approach to studying seismic conditions has recently made it possible to quantitatively evaluate the seismicity of the Minor Caucasus. Raw data for 1952-1968 [1,2] and for 1962-1872 [3] were used. As we know, the longer the observation time, the more dependably seismicity indicators are determined. But it is more important for the raw data to be reliable over an extremely short period of time.

The most accurate data on earthquakes in Armenia accumulated over the last 8-10 years permitted us to use Riznichenko's well-known procedure [4] to plot maps of seismic activity (A) and maximum possible earthquakes (K_{max}).

In the period from 1962 to 1980 earthquakes with $K \geqslant 9$ are reliable representatives for the territory under study, and therefore we used seismic quakes beginning with the ninth energy class.

To calculate seismic activity we used the method of summation at constant precision. The map (Figure 1a) was plotted in isolines using a number 0.5 circular measuring grid. The slope of the curve was adopted at $\gamma = 0.5$, while the period of observation was adopted as $T = 19$ years. Activity was related to a 1,000 km^2 area.

The law of recurrence of earthquakes on the Armenian Plateau was studied sufficiently thoroughly by Karapetyan on the basis of data covering 290 years (1679-1968). According to this research the slope of the recurrence curve is 0.52 (using the summation method) and 0.51 (using the distribution method) [1].

It should be noted that according to observations for 1962-1970, with and without regard for the grouping of earthquakes, the slope of the recurrence curve for the Caucasus as a whole and separately for Georgia and for Dzhavekhetskoye Plateau is almost identical and equal to 0.5 [3]. We obtained almost the same value for the Armenian SSR in 1962-1980.
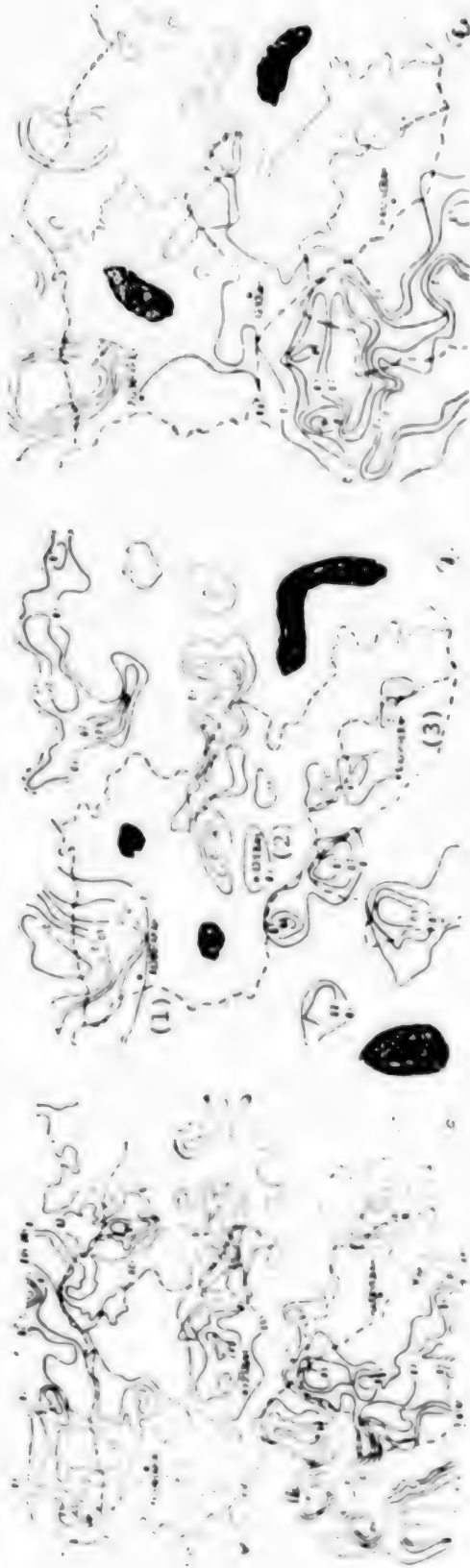
Figure 1. Maps Showing Seismic Activity in the Armenian SSR and Contiguous Regions, Based on Seismological Data for 1962-1980 (a), 1962-1970 (b) and 1971-1980 (c)

Key: 1. Leninakan   3. Nakhichevan
       2. Yerevan

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As follows from the map, the vicinity of the Vaspurakanskiye Mountains is characterized by a relatively vast area of activity with a magnitude of up to unity; several isolated maximums are present in this area as well. The Dzhevakhetskoye Plateau, Zangezur and the vicinities of the mountains Chobandag and Bol'shoy Ginaldag are also characterized by maximum activity. The central part of the Armenian SSR also stands out as a zone with activity with a magnitude of up to 0.5, conforming with the Yerevan-Sevan graben-synclinorium [5]. The republic's northeast, Oktemberyanskiy Rayon, the Syunikskiye Mountains and central Nakhichevan ASSR fall within a zone of relatively weak activity.

Two activity maps were plotted with the purpose of studying changes in activity in the 1960s and 1970s (Figure 1*b*, *c*). Significant change in activity is observed in the southwestern part of the territory under investigation, where both the area of the zone of high activity and its magnitude change. This pattern may be explained both by changes in seismicity and by improvement of the conditions of seismic recording. The zone of high activity on the Dzhavakhetskoye Plateau also changed in area. In our opinion the second map is more characteristic, and it reflects the zone's seismic activity relatively more accurately.
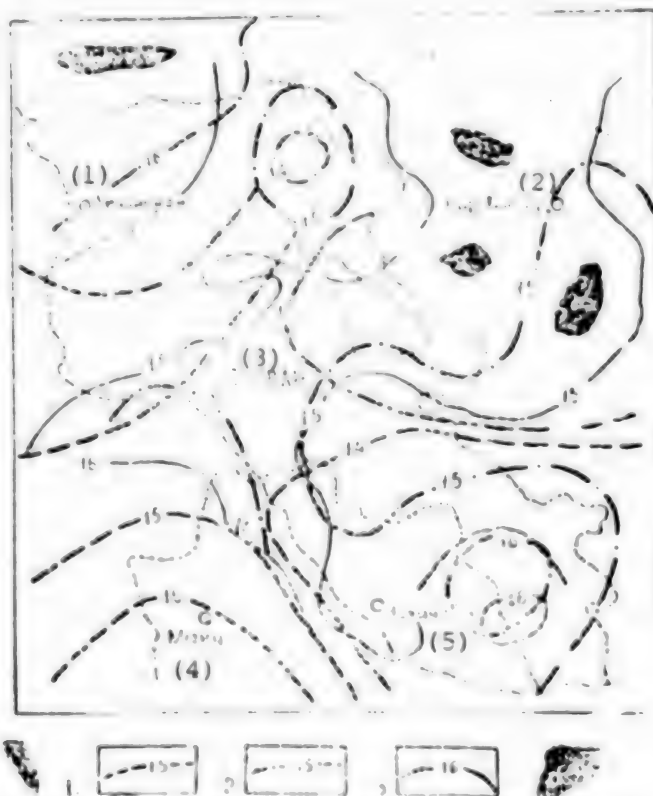
Figure 2. Map of Maximum Possible Earthquakes K_{max} (*A*) in the Armenian SSR and Contiguous Regions: *1*--1952-1968 [2]; *2*--1962-1973 [3]; *3*--1962-1980

Key:
1. Leninakan
2. Kirovakan
3. Yerevan
4. Maku
5. Nakhichevan

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A map of maximum possible earthquakes (Figure 2) was plotted on the basis of data for 1962-1980 using new dependencies between the energy of strong earthquakes in the Caucasus and the mean seismic activity in the zone surrounding the epicenter [2]. For the purposes of comparison the map also shows similar data obtained by Dzhibladze, Karapetyan and Manukyan for different periods of time. In contrast to existing maps, our map is based on new, relatively accurate data covering a large period of time.

It follows from these results that the maximum possible earthquake for the Armenian SSR and contiguous regions has a value of $K_{max} = 16$. This is natural, since stronger earthquakes were not recorded in the territory under investigation within recorded history. However, the zones of maximum possible earthquakes cited by different authors differ noticeably from one another. The zone with $K_{max} = 16$ in the northwestern Armenian SSR is more or less the same as the zone in the republic's center, for which $K_{max} = 15$. The Yerevan-Sevan graben-synclinorium is characterized by slightly higher values for K_{max} (though far from $K_{max} = 16$) in comparison with neighboring regions.

Relatively greater discrepancies between K_{max} figures based on different raw data are observed in the southeast of the territory under analysis. In our opinion data which result in a figure of $K_{max} = 16$ for the area of known earthquake centers of the Zangezur Mountains are the closest to the truth.

Treating the southwestern portion of the map as an area with $K_{max} = 16$ does not contradict the historical macroseismic data.

We note in conclusion that it would incorrect to use maps of maximum earthquakes as the basis for determining the seismic danger of the territory, since strong earthquakes do not always occur in regions where moderate earthquakes happen the most frequently, while the procedure of determining K_{max} depends on precisely such a relationship. The obtained map provides only some idea of the possible strongest earthquakes of the given region.

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CONFERENCE ON SEISMIC ZONING AND STUDY OF POWERFUL EARTHQUAKES

Kishinev SOVETSKAYA MOLDAVIYA in Russian 2 Jun 84 p 3

[Text] Achievements of seismology and seismic construction and prospects
for their advancement were discussed at an all-Union conference, "Seismic
Zoning of the USSR's Territory and the Study of Powerful Earthquakes",
Kishinev. This conference was organized by the interagency council on
seismology and seismic construction under the presidium of the USSR Academy
of Sciences and by the Moldavian Academy of Sciences' Institute of Geophysics
and Geology. Taking part in the conference were about 200 scientists repre-
senting leading centers of the country that are studying this problem.

In addition to geologists, geophysicists and seismologists, the conference's
participants included specialists in earthquake-resistant construction, which
will further the establishment of closer ties among these specialists and
permit the substantial shortening of lead time for the introduction of
scientific developments into practice.

It was not by change that Moldavia was chosen as the place for holding the
all-Union conference. Scientists of the Academy of Sciences of Moldavia, which
is located near the Vranch center of seismic activity, have perfected a new
non-standard method for studying earthquakes which makes extensive use of
computer te hno ogy. This method has been tested in a number of other large
regions of the world. The method will provide a good basis for compiling
a global map of seismic danger, which will make it possible to issue
recommendations for regions of our country which are characterized by dif-
ferent engineering-geophysical conditions, and to reduce seismic risk in
construction in zones where earthquakes are possible.

FTD/SNAP
CSO: 1865/192

EARTHQUAKE PRECURSOR PHENOMENA DETECTED WITH ACOUSTIC TRANSDUCERS

Frunze SOVETSKAYA KIRGIZIA in Russian 2 Jun 84 p 2

[Text] Ashkhabad--Instruments developed in collaboration with Moscow
scientists have helped specialists of the Turkmen Academy of Sciences'
Institute of Seismology to monitor the 'breathing' of the Earth's interior.
Sensitive acoustic transducers placed in deep boreholes and on the Earth's
surface detect the moment when microscopic cracks form in the Earth's solid
crust. These cracks form as a result of ebbs and flows in molten rock and
of various internal stresses which often lead to fractures and movements
of the Earth's crust--earthquakes.

"By the increase of underground 'noises', we can pinpoint the place where
perceptible vibrations are anticipated," related B. Karryyev, head of the
Institute's instrument seismology laboratory. "We determine the contours of
the epicenter of impending underground tremors on the basis of these long-
term precursor phenomena of earthquakes. It has been established, for
example, that strongly increasing 'noises' that are direct predecessors of
tremors originate 10 to 12 hours before an earthquake, as practice has shown."

FTD/SNAP
CSO: 1865/162

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POSSIBLE PETROLEUM-PRODUCING STRATA IN DEPTHS OF WORLD OCEAN

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[Abstract] A study was made of the relationships between petroleum and gas reserves and the concentration of C_{org}. There is a clearly expressed direct correlation between petroleum reserves and the C_{org} concentration for the overwhelming part of the Phanerozoic. At the extreme ends of the Phanerozoic scale the direct correlation between the content of C_{org} and petroleum reserves becomes inverse: an increase in the C_{org} content corresponds to a decrease in petroleum reserves. The inverse correlation between the considered parameters observed for Quaternary deposits in comparison with the dominant background is attributable to the fact that this stratigraphic complex, situated at a shallow depth beneath the ocean floor, did not experience katagenesis conditions and could not realize its petroleum-generating potential. There is no adequate information concerning the distribution of C_{org} in Paleozoic deposits of the continental margins. The sequence of change in the content of C_{org} and petroleum reserves in the cross section of the Phanerozoic leads to the important genetic conclusion that reserves of fluid hydrocarbons in the depths of the world ocean are distributed in rigorous accordance with the distribution of petroleum-generating organic matter. The layers of the sedimentary stratum of the Phanerozoic, having good petroleum-generating characteristics, are the principal petroleum-bearing complexes. This important conclusion is a convincing confirmation of the leading role of the lateral migration of hydrocarbons in petroleum accumulation processes in deposits, this being one of the fundamental points in the theory of sedimentary-migrational origin of petroleum. The mentioned correlation of parameters is observed only for the Atlantic and Indian Oceans. In these oceans the maximum petroleum and gas reserves are associated with sediments of Cretaceous, primarily Lower Cretaceous age. On the other hand, the sedimentary stratum of the continental margin of the Pacific Ocean is in general characterized by reduced initial contents of disperse organic matter for petroleum formation and accordingly small reserves of petroleum and gas. There is also a different form of distribution of the correlated parameters in a rather narrow range of stratigraphic intervals of the section. The relative maxima of petroleum and gas reserves are in Paleogene deposits and extremely low reserves are observed in Cretaceous deposits. The

distribution of hydrocarbons in the sedimentary rock basins of the oceans conforms to patterns reflecting their sedimentary-migrational origin. Figures 2; references 7: 3 Russian, 4 Western.
[119-5303]

PALEOTECTONIC AND PALEOHYDROGEOLOGICAL RECONSTRUCTIONS IN EVALUATING PROSPECTS FOR FINDING PETROLEUM AND GAS

VAGIN, S. B., SAMSONOV, Yu. V., DONGARYAN, L. Sh. and SHASHIN, A. V., Moscow Order of Labor Red Banner Institute of the Petrochemical and Gas Industry imeni I. M. Gubkin

[Abstract] The region discussed is the northeastern part of the Siberian Platform, the Vilyuyskaya syneclise and the Priverkhoyanskiy downwarp. This is a major unified sedimentation basin characterized by a uniformity of the processes of lithogenesis, gas and petroleum formation and accumulation of hydrocarbons. The Upper Paleozoic and Mesozoic deposits are characterized by six regional gas-petroleum-water bearing complexes (GPWC): Permian-Lower Triassic, Lower Triassic, Middle- -Upper Triassic, Lower Jurassic, Middle- -Upper Jurassic and Upper Jurassic - Lower Cretaceous. The following studies were made for analyzing the history of formation of this sedimentation basin, reconstruction of paleohydrogeological conditions and accumulation of hydrocarbons: a) study of paleotectonic conditions for the formation of GPWC with the discrimination of sectors of different intensity of downwarping; b) determining the hydrogeological periods for each of the discriminated complexes; c) analysis of formation of the structural plan of individual GPWC and reconstruction of the paleohydrodynamic conditions in the sedimentation basin. This approach made possible a differential approach to evaluation of the prospects for finding petroleum and gas in each regional GPWC with the discrimination of regions of generation, possible directions of migration and accumulation of fluids. Each of the GPWC are discussed in detail. Diagrams of thicknesses with the discrimination of hydrodynamic regimes were constructed for studying the paleotectonic and palehydrogeological history of the region. For each of the considered periods in geological development of the region it was possible to discriminate regions of piezomaxima corresponding to sectors of maximum downwarping of the bottom of the sedimentation basin and accumulation of the maximum thickness of sediments, regions of piezominima corresponding to territories experiencing relatively slow downwarping and intermediate regions which can be regarded as possible migration paths for hydrocarbons. It was possible to determine the regions which during the prolonged history of development of the region served as zones of piezomaxima; the generation of hydrocarbons occurred in these. The various paleotectonic and paleohydrogeological criteria indicate that the Permian-Lower Triassic, Lower Triassic and Middle- - Upper Triassic complexes are the most promising. Figure 1; table 1.
[102-5303]

RELATIONSHIP BETWEEN CRUSTAL STRUCTURE AND MAJOR PETROLEUM-GAS ACCUMULATION ZONES

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[Abstract] The interrelationship between structure of the crust and major zones of petroleum and gas accumulation is examined. The authors correlate deep crustal structures and the distribution of major petroleum- and gas-bearing basins. The investigation was made applying the concepts formulated by I. M. Gubkin. Emphasis is on Eurasia, is being the best-studied of the continental land masses; the text is accompanied by a map of crustal structure in Central Eurasia. Within Western and Central Eurasia there are several generations of structures with a femic crust. Downwarps with an ancient femic crust in which sedimentation occurred in the Paleozoic and Riphean are one of the varieties of those structures most promising in the search for petroleum and gas. Such structures are found on the West Siberian Platform, in the Caspian Lowland and in the Persian Gulf. A completely different generation of basisn with a Paleozoic granite-free crust, forming in the course of basification of the North Atlantic margins, includes parts of the North Sea Basin promising for petroleum and gas; other examples are the Tersko-Caspian downwarp, Aral Sea and Amu Darya depressions. A third generation of Alpine-Cenozoic zones of basification developed primarily in the Mediterranean Sea zone, but these have a very low productivity of petroleum and gas. These are but a few examples cited in the article of different crustal formations characterized by high or low productivity. A whole series of promising regions is listed; some of these, very poorly studied at the present time, merit exploration by geophysical surveys and drilling. Attention to the relationship between crustal structure and probability of the presence of petroleum and gas, as made clear by the authors, will provide clues ensuring further development of production of these forms of hydrocarbons. Figure 1.
[102-5303]

CRUSTAL STRUCTURE OF EASTERN KAZAKHSTAN ACCORDING TO DATA OBTAINED BY SEISMIC PROSPECTING BY REFLECTED WAVES METHOD

AKISHEV, T. A., KLIMOV, A. A. and SHMAKOV, Yu. G., Kazgeofizika Geological Production Association

[Abstract] A regional seismic prospecting profile was run between Balkhash and Altay for studying the deep crustal structure of

Eastern Kazakhstan. Work along this profile was by the reflected waves method, modified for investigating the deep crustal levels of folded regions. This was the first Soveit experience in regional crustal study by intermediate-frequency seismic prospecting by the reflected waves method with registry of subcritical reflections along such a lengthy line. It made it possible with great reliability and detail to obtain seismic reflecting elements from depths between 5 and 30 km and deeper than when using deep seismic sounding methods. It was therefore possible to register seismic reflecting elements from depths of 25-30 km, and in individual sectors up to 45-50 km. The authors discuss the principles for the interpretation of seismic reflecting elements and a general model of the crust, followed by a description and discussion of crustal structure along the profile, accompanied by a detailed diagram of the crustal section along this line. The lithosphere has a complex structure here caused by a combination of gently dipping and subvertical tectonic elements. There are two types of geotectonic structures--folded zones and geoblocks. Within the folded zones there are two types of blocks--paleorift and continental. Figures 3; references: 15 Russian.
[102-5303]

DEVELOPMENT OF RESEARCH ON PREDICTION OF EARTHQUAKES, TSUNAMIS AND VOLCANIC ERUPTIONS IN FAR EAST

[Unsigned article]

[Abstract] S. A. Fedotov, corresponding member, USSR Academy of Sciences, director of the Volcanology Institute, Far Eastern Scientific Center, USSR Academy of Sciences, recently presented a report on advances in research on prediction of earthquakes, tsunamis and volcanic eruptions in the Far East at a session of the USSR Academy of Sciences Presidium. In the USSR 80% of all the earthquakes occur in that region and there are 77 active volcanoes. The principal danger is from earthquakes in the Kuril-Kamchatka region, where focal zones have a length as great as 600-700 km. A new map of seismic regionalization of the USSR was published in 1980. Petropavlovsk-Kamchatskiy is situated at a particularly dangerous site; other major cites in seismically dangerous zones are Yuzhno-Sakhalinsk, Magadan and Nakhodka. Much work has been done on long- and short-range seismic prediction. During 1963-1965 a method was developed for determining the probable sites of future intense earthquakes. In the Kuril-Kamchatka seismic zone during the last 20 years there were 5 earthquakes with a magnitude $M \geq 7\ 3/4$; all occurred in places which were considered dangerous according to the long-range prediction. A knowledge of the properties of the seismic cycle makes it possible to predict the probable number of weak and intermediate earthquakes in all sectors of the Kuril-Kamchatka arc. Such predictions have been made for 20 years for 5 years in advance for 13 sectors of the Kuril-Kamchatka arc. These predictions have been 70% successful. Prediction of the time of

strong earthquakes has been improved by the discovery of a dependence between the number of these earthquakes and the phase of the lunar tide with a period of 18.6 years. For Kamchatka the next dangerous period began in June 1983 and will continue until June 1990. The probability of occurrence of earthquakes with a magnitude $M \geq 7$ in such periods will increase to 83%. In the field of short-range prediction a search for precursors has centered on study of the statistics of earthquakes, the patterns of distribution of their foci, earthquake spectra, deformations of the earth's surface, anomalies of earth currents, discharge and chemical composition of ground water. Work on the search for precursors has been concentrated near Petropavlovsk-Kamchatskiy and in the Southern Kurils using systems of telemetric seismic and tiltmeter stations, repeated geodetic measurements, measurements of the magnetic field and seismic probing. There have been some successes in short-range prediction. The tsunami danger has been regionalized; it is taken into account in construction work on the Pacific coast of Kamchatka and the Kurils. One of the most important problems in operation of the tsunami-warning system is the reduction of false alarms. Further improvement in regional work dictates an expansion of the network of seismic and geophysical stations. The report and the discussions which followed outlined the need for many other improvements and resolutions were passed in order to implement the required work. [112-5303]

GROWTH OF DOME IN CRATER OF SHIVELUCH VOLCANO IN 1980-1981 ACCORDING TO PHOTOGRAMMETRIC DATA

DVIGALO, V. N., Volcanology Institute, Far Eastern Scientific Center, USSR Academy of Sciences

[Abstract] Shiveluch Volcano erupted in 1980-1981, during which time an extrusive dome was formed in the crater. The eruption began on 23 August and ended in late 1981. Aerial photogrammetric observations of the state of the crater have been made since 1979, involving stereophotogrammetric processing of periodic near-vertical aerial photographs for obtaining its quantitative parameters. A horizontal-vertical control was provided by a geodetic network laid out in 1979. Photographs taken on 2 September 1979 were used in compiling a relief map of the central part of the crater (maximum diameter 1,750 m, wall height varying from 580 to 170 m). There was a domelike rise in the northeastern part of the crater floor. The last aerial survey prior to the eruption was on 3 July 1980. The photos for this data and 2 September 1979 were compared to detect vertical displacements of the crater surface. Digital models of crater relief were constructed for this purpose using a rectangular grid with a 5-mm interval at a scale of 1:5,000. During the eruption an aerial survey was made each

month. A dome developed at the site of the domelike rise which had
formed in 1964. It appears that the dome matter was at a small depth
prior to the eruption. Its appearance at the surface in 1980 occurred with-
out special stresses and active seismic preparation. The dome grew most
intensively in the first two months of the eruption when the average dis-
charge of matter was 186,000 m^3 daily and the average growth rate was
2.5 m/day. It is postulated that the diameter of the volcanic vent from
which this matter was expelled is 250-300 m. Figures 7; table 1;
references: 4 Russian.
[146-5303]

SEISMOGEOLOGICAL MODEL OF EASTERN ZONE OF CENTRAL AND SOUTHERN SAKHALIN

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Sciences, Yuzhno-Sakhalinsk

[Abstract] Already existing seismogeological models for Sakhalin Island
are analyzed; these cannot be used applicable to any specific zone of the
island. Accordingly, the authors have proposed a new seismogeological model
prepared for the eastern zone of the island, accompanied by a discussion of
the initial data used in its compilation. It is shown that the new model
can serve as a basis for developing a method for investigations by the re-
fracted waves method in the adjacent water area of the Sea of Okhotsk and the
subsequent interpretation of seismic data. Figure 2 is a map indicating the
degree of seismic study of this particular area by the refracted waves
method; Fig. 3 is a seismogeological model of the area based on these ob-
servations. This model of the upper part of the sedimentary cover is
characterized by the following seismic sections corresponding to the
surfaces of the principal structural stages: V_b = 2.2 km/sec -- Neogene
stage, V_b = 4.0-4.4 km/sec -- Upper Cretaceous stage; V_b -- 4.8-5.3 km/sec --
Jurassic-Lower Cretaceous stage, V_b = 5.6-6.4 km/sec -- Middle-Upper
Paleozoic stage. These seismic sections are sustained over considerable
areas and therefore can be used as really existing structural geology
sections of the upper part of the sedimentary complex. There is every
reason to believe that these formations extend into the territory of the Sea
of Okhotsk adjacent to Sakhalin. Figures 4; tables 2; references: 14 Russian.
[118-5303]

INTERPRETING THREE-DIMENSIONAL GRAVITATIONAL AND MAGNETIC ANOMALIES

TSIRUL'SKIY, A. V., MAYER, V. I., NIKONOVA, F. I., PRUTKIN, I. L. and
FEDOROVA, N. V., Geophysical Institute, Ural Scientific Center, USSR
Academy of Sciences, Sverdlovsk

[Abstract] In the absence of reliable a priori information on the physical
properties of sources there is no way to obtain a unique solution of inverse
problems in gravimetry and magnetometry and therefore in the interpretation
of anomalies the existence of equivalent solutions of inverse problems must
be taken into account. In an earlier article by A. V. Tsirul'skiy (IZV.
AN SSSR: FIZIKA ZEMLI, No 7, 1974) the idea was expressed that the inter-
pretation of data from gravitational and magnetic prospecting can be broken
down into two stages. The observed field is approximated by the field of
some number of singular sources in the lower half-plane. At this stage
there is no need for any hypotheses concerning the number of sources and
their physical properties. Near-lying singular sources are assumed to be-
long to the field of one homogeneous object; different variants of joining
of sources can be tested. In this case the problem which must be solved
is as follows: on the basis of some of the potential derivatives, stipulated
in explicit form, it is necessary to find an equivalent family of solutions.
This can be called the theoretical inverse problem. Specific objects must
be selected from the equivalent families, taking the available geological
information into account. The advantage of this approach is that there are
no undesirable hypotheses concerning the properties of the sources. Here
the authors derive simplified nonlinear equations for the three-dimensional
theoretical problem in gravimetry and magnetometry. The results of applica-
tion of the model are given. Figures 3; references: 9 Russian.
[118-5303]

PHYSICS OF ATMOSPHERE

CHANGES IN EARTH'S ROTATION RATE CAUSED BY ZONAL TIDE AND THEIR
MANIFESTATIONS IN ATMOSPHERIC PRESSURE FIELD

RUDYAYEV, F. I.

[Abstract] Atmospheric pressure changes associated with tidal changes in
the earth's rotation rate are examined in the example of the semiannual solar
tide. In the article it is shown that the observed semiannual changes in
atmospheric pressure at the earth's surface both qualitatively and quanti-
tatively are attributable to real changes in the earth's rotation rate
caused in turn by the semiannual solar tide. But the semiannual atmospheric
pressure changes are not tidal because they are not caused directly by the
tide-generating force. The direct cause of the semiannual changes in
atmospheric pressure is changes in the earth's rate of rotation and there-
fore such atmospheric pressure changes are most correctly called rotational.
This mechanism of semiannual changes in atmospheric pressure can be applied
to the entire spectrum of zonal long-period tides. Atmospheric pressure
changes in the rhythms of long-period tides are a reflection of real tides
in the earth's hydrosphere and lithosphere. Even very small (such as
1.4 cm) tidal changes in position of the level surface can be manifested
considerably in changes in the equatorial moment, earth's rate of rotation
and meridional movements of atmospheric masses associated with this. The
amplitude of rotational changes in atmospheric pressure with a periodicity
of 18.61 years is 0.90 of the amplitude of semiannual changes in atmospheric
pressure. The mean amplitude of rotational changes in atmospheric pressure
with a period of 18.61 years in the earth's polar regions is 3.6 gPa and
in the tropical regions it is 2.4 gPa. The materials presented in this
article explain rhythmic changes in the intensity of atmospheric circulation
and many meteorological parameters having a semiannual, 3.5-, 7- and 18-19-
year periodicity are manifestations of changes in the earth's rotational
regime. Figure 1; references: 6 Russian.
[120-5303]

QUASI-TWO-DAY VARIATION OF LOWER THERMOSPHERE WIND VELOCITIES

KAYDALOV, O. V., MAKAROV, N. A. and PORTNYAGIN, Yu. I., Institute of
Experimental Meteorology

[Abstract] Data on the wind regime at altitudes 80-100 km reveal a regular
oscillation in wind velocity variations with a period close to two days, the
quasi-two-day variation. The authors here give the results of a theoretical
study of these variations on the basis of a numerical model. Already
published data are generalized and new data are analyzed. The comparison
of the results of numerical modeling and experimental data indicated a
satisfactory agreement between the two. The seasonal variation of the
amplitudes of wind velocities determined from the results of numerical
modeling coincides completely with the seasonal variation detected experi-
mentally. The presently available experimental data on the latitudinal-
vertical structure of the quasi-two-day variation are explained in large
part by the model computations presented here. Certain quantitative differ-
ences between theory and experimental data, such as the fact that the great-
est amplitudes of quasi-two-day variations are in the southern hemisphere,
can be caused by seasonal changes in the source of the quasi-two-day variation
about which nothing is now known. Due to the effect of Hall conductivity and
viscosity the quasi-two-day variation is intensively destroyed in the lower
thermosphere and its momentum and energy are imparted to the atmosphere.
Since the seasonal variation of amplitudes of the quasi-two-day variation
has a semiannual period, this variation can be regarded as a source of
energy and momentum in the lower thermosphere with the same period. The
variation with a period of 51 hours observed at Obninsk-Khabarovsk is a
planetary wave propagating from east to west. Figures 2; references 21:
7 Russian, 14 Western.
[132-5303]

STABILITY CRITERION FOR MOIST COMPRESSIBLE ATMOSPHERE AND ENERGY CONDITIONS
FOR DEVELOPMENT OF CONVECTIVE CLOUD COVER: NUMERICAL EXPERIMENT

VUL'FSON, A. N., USSR Hydrometeorological Center

[Abstract] In this study of stability of a moist compressible atmosphere
it is assumed that the background atmosphere is conditionally unstably

stratified, $\gamma_m < \gamma < \gamma_d$, where $\gamma = -d\overline{T}/dz$ is the background temperature gradient; γ_d, γ_m are the dry adiabatic and moist adiabatic gradients. The stability of a moist static atmosphere was first studied by Bjerknes (he assumed that the condensation region D_m and the region of dry descending air D_d are vertical cylinders of an identical height H_0 with constant sections S_m and S_d). He established that the stability of one-dimensional stepped vertical movements of moist air is determined by the sign of the parameter VB. When VB < 0 there is instability, but when VB $\geq$ 0 disturbances have a stable character. Bjerknes postulated that the evolution of convective cloud cover can be related to a change in the stability parameter VB so that the condition VB < 0 corresponds to the stage of development of cloud cover, whereas under the condition VB = 0 cloud cover attains the mature stage of its development. In this article the author proposes a generalization of the Bjerknes criterion. It is demonstrated that the stability of a moist static atmosphere can be characterized by the sign on the parameter VP, in whose formulation the configuration of the D_m and D_d regions is assumed to be arbitrary. The stability parameter is computed and numerical experiments are described which simulate the development, mature phase and decay of a convective cloud. Adhering to the Bjerknes concept, the evolution of a convective cloud is examined from the point of view of stability theory. An energy interpretation is also proposed for interpretation of cloud development which is based on the law of energy conservation. Figures 3; references 14: 8 Russian, 6 Western.
[132-5303]

EFFECT OF ANTISCREENING OF OUTGOING THERMAL RADIATION BY CLOUD COVER

MOKHOV, I. I., Institute of Atmospheric Physics, USSR Academy of Sciences

[Abstract] The author examines one of the aspects of the response of radiation fluxes in the earth's climatic system to a change in cloud cover. The article gives the conditions for satisfaction of $\partial F_\uparrow/\partial_n \geq 0$, antiscreening of outgoing thermal radiation $F_\uparrow$ with a change in the quantity n of macroscale cloud cover. It was found that the possibility of a positive sing on $\partial F_\uparrow/\partial_n$, obtained on the basis of real data on the annual variation, is not only a property of a specific empirical or theoretical model. The effect of antiscreening of outgoing thermal radiation by cloud cover is manifested in a number of models and in empirical regressions. A further analysis of empirical data and models is required for confirmation of the climatic significance of this effect. The conditions for stratification of the integral transmission function, thermal structure and positioning of the levels of the upper cloud boundary for which $\partial F_\uparrow/\partial_n \geq 0$ were determined. In models of outgoing thermal radiation with single-layer cloud cover the

antiscreening effect is possible only in the presence of temperature inversions in the subcloud atmosphere or at the surface. In models with multilayer cloud cover the redistribution of clouds at different levels leads to a change in the height of the effect cloud cover layer and to the possibility $\partial F_\phi / \partial_n \geq 0$. In this case the presence of temperature inversions is not mandatory and the antiscreening effect can be manifested at any latitudes. The sign and value of $\partial F_\phi / \partial_n$ in the inhomogeneous earth's climatic system are dependent on the scales of spatial-temporal averaging. In determining the total effect of antiscreening of outgoing thermal radiation by cloud cover all the climatic variables and parameters functionally related to cloud cover are varied, including the thermal structure, humidity field and position of cloud levels. In most cases of stratus clouds the vertical temperature gradient in the cloud layer is less than in the cloudless atmosphere. This favors the appearance of the full antiscreening effect. Figures 3; tables 2; references 28: 16 Russian, 12 Western.
[132-5303]

STATISTICAL THEORY OF AUREOLE PHENOMENON

VEBER, V. L., Institute of Applied Physics, USSR Academy of Sciences

[Abstract] The phenomenon of the light aureole around the shadow of an observer in the water is examined in detail. It can be explained in the following basis. The wave-covered water surface acts on the incident solar radiation as a set of a great number of collecting and scattering lenses which cause "thickening" and "thinning" of the light radiation under water. The regions of "thickening" are drawn out in the direction of the sun's rays, with light "jets" being formed in the water. They become visible due to the presence of scattering particles in the water. With observation of these parallel light jets through the water surface they seem to be convergent at a single point, the shadow of the observer's head. The latter is attributable exclusively to the perspective effect. In this article the author presents a statistical model of this phenomenon on the basis of the theory of formation of the light field in a turbid medium in the presence of a randomly uneven refracting surface. The aureole phenomenon also exists for an observer who is under water at a shallow depth. This only confirms that the aureole is a manifestation of the lens effect of a wave-covered water surface due to light radiation from above. The model cannot answer the question as to the conditions under which the aureole is best observed, but it is known that the phenomenon is virtually never observed in very transparent and in very turbid waters. The phenomenon has practical importance in interpreting many other problems in marine optics. Figures 3; references: 9 Russian.
[132-5303]

ACCURACY OF ONE APPROXIMATE METHOD FOR COMPUTING RADIATIVE FLUXES IN
PRESENCE OF BROKEN CLOUDS

SKORINOV, V. N. and TITOV, G. A., Institute of Atmospheric Optics, Siberian
Department, USSR Academy of Sciences

[Abstract] The stochastic transfer equation is the basis for a physically
and mathematically sound solution of any study of radiation transfer in
broken clouds. By the averaging of this equation in a set of cloud field
observations it is possible to arrive at equations for intensity moments of
any degree in a Markov approximation. An algorithm was written for computing
mean intensity by the Monte Carlo method. An asymptotic form of the mean
intensity equations is obtained for a case when the horizontal extent of the
clouds is much greater than their vertical extent. Estimates are made of the
accuracy of this asymptotic method in computations of mean radiative fluxes
in the presence of broken clouds with real geometrical and optical parameters
of individual clouds. The relative error in computing the mean radiative
fluxes by the Monte Carlo method does not exceed 2-3%. The mean intensity
equations in the Markov approximation proposed here are equivalent to the
mean radiative fluxes in the "open-closed" approximation. The latter
approximation describes well the transfer of radiation in broken clouds
consisting of stratiform forms whose horizontal dimensions are ~10 km or more.
The mean horizontal dimension of cumulus clouds, computed using experimental
distribution functions, varies in the range of 0.5-2 km and therefore the
"open-closed" approximation in general is inapplicable for solution of the
problem of transfer of optical radiation when cumulus clouds are present,
except when the extinction coefficient is small. Figures 6; references 14:
13 Russian, 1 Western.
[132-5303]

EXTINCTION COEFFICIENT OF PRECIPITATION WATER IN REGION 200-1100 nm

ROMANOV, N. P. and SHUKLIN, V. S., Institute of Experimental Meteorology

[Abstract] The article gives the results of a study of the extinction
spectra of precipitation water collected during different seasons in the
neighborhood of Obninsk and not subject to the industrial influence of any

large city. The measurements were made during 1978-1981. Thirty water
samples were collected (a total of about 450 mm of precipitable water).
It was found that the mean values of the extinction coefficient considerably
exceed the absorption coefficient of distilled water at wavelengths $\lambda < 600$ nm.
The greatest contribution to the precipitation water extinction coefficient
in the region 350-600 nm is from the coarse disperse aerosol fraction with
particle sizes ≥ 1 µm. The mean values of the extinction coefficient due to
this fraction are $0.5-1.0$ m^{-1} and have a virtually neutral variation in this
region. The fine disperse fraction (particle size hundredths of a µm) exerts
an influence on the extinction coefficient in the region $\lambda < 600$ nm in only
a few cases, but makes a considerable contribution to the mean values of the
extinction coefficient in the region 400-600 nm. True absorption in the
region 250-600 nm is caused by impurities of an organic nature, and in the
region $\lambda < 250$ nm also by nitrate ions. In the region $\lambda > 650$ nm impurities
of a molecular nature and also the fine disperse fraction make no contribu-
tion to the precipitation water absorption coefficient. Figures 2;
table 1; references 13: 11 Russian, 2 Western.
[132-5303]

SMALL-ANGLE METHOD IN STUDY OF SINGLE AND MULTIPLE SCATTERING

BELOV, V. F., BOROVOY, A. G., VAGIN, N. I. and VOLKOV, S. N., Institute
of Atmospheric Optics, Siberian Department, USSR Academy of Sciences

[Abstract] In the case of multiple scattering (solution of the radiation
transfer equation) the small-angle approximation has been well studied.
This approximation is attractive for practical applications due to the
simple analytical formulas for solution of the radiation transfer problem.
The small-angle approximation coincides with the approximation of a Markov
random process in the theory of wave propagation in random media. In the
case of plane-parallel problems the analytical expressions for solution of
the radiation transfer problem in a small-angle approximation can be con-
siderably simplified. In this article the authors derive a simple analytical
expression for solution of the radiation transfer equation, expressed through
the optical thickness and the autocorrelation function of the shadow from an
individual particle. In this case the finding of the ray intensity is reduced
to numerical computation of a one-dimensional integral. This article gives
the results of such computations with an electronic computer. It is shown
that the expressions for single scattering are naturally included in the
derived multiple scattering expressions and the small angle method can be
used successfully in the case of multiple scattering as well. The applica-
tion of the results to solution of inverse problems by the small angle

method is discussed, as well as the limits of applicability of the small-angle radiation transfer problem approximation. Figure 1; references: 14 Russian.
[132-5303]

RESONANCE ABSORPTION OF NARROW-BAND LASER RADIATION BY ATMOSPHERIC GASES

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[Abstract] The transmission function in the case of resonance interaction of narrow-band laser radiation has the form

$$T(\nu_e) = \int g(\nu_e, \nu, \Gamma_0) \exp\{-\tau(\nu)\} d\nu, \tag{1}$$

where $\tau(\nu)$ is the optical thickness at the frequency ν,

$$\tau(\nu) = \int_{H_1}^{H_2} B_\nu(h)\alpha(\nu,h)dh. \tag{2}$$

The following notations are used: $g(\nu_e, \nu, \Gamma_0)$ is a function, normalized to unity, describing the contour of the emission line with the center ν_e; Γ_0 is the half-width of the emission spectrum; $\alpha(\nu,h)$ is the volume coefficient of molecular absorption; $B_\nu(h)$ is the ray path function; H_1, H_2 are the boundaries of the absorping layer. Existing methods for evaluating atmospheric transmission were developed for wide-band sources. The absorption spectra models method does not make it possible to obtain simple analytical formulas for a wide range of $\tau(\nu)$ change and width of the emission spectrum. In the solution presented here it is assumed that the distribution of intensity of laser radiation in the spectrum is Gaussian, which is typical for most lasers with a narrow spectrum. A table gives the spectral characteristics of ruby and CO_2 lasers and the maximum lengths of horizontal paths L_{max} for which withaan error not greater than 10% the evaluation of the transmission function in a monochromatic approximation is correct. Figures 2; table 1; references 7: 6 Russian, 1 Western.
[132-5303]

INTERPRETING SPECTRA OF SEA SURFACE AERIAL PHOTOGRAPHS

LUCHININ, A. G., Institute of Applied Physics, USSR Academy of Sciences

[Abstract] The image of the sea surface formed in the visible spectral
range includes information on surface waves; the spatial spectrum of aerial
photographs of the surface corresponds to the spectrum of wave slopes. But
modulation of brightness of the sea surface by waves can be caused by differ-
ent physical factors. Proper interpretation of the spectra requires that the
role of each of them be evaluated. In this article a study is made of the
joint influence of two such factors: angular nonuniformity of sea surface
illumination and the dual focusing phenomenon arising with the double trans-
mission of light through the wave-covered air-water interface. It is shown
that the contribution of the dual focusing effect is important in an
extremely wide range of spatial scales. It is possible to characterize the
spectral dependence of the relative contribution of the dual focusing effect
to the formation of brightness fluctuations more completely by introducing
the parameter $\alpha^* = \max \alpha(k)$ and the spatial frequency k^* showing at what
spatial scales a maximum of the function $\alpha(k)$ is formed. These parameters
are computed as a function of optical wavelength. The contribution of the
dual focusing effect is most conspicuous in the region of wavelengths
$\lambda \sim 500$ nm. Its maximum (the $\alpha^*(\lambda)$ parameter) for different parts of the
optical spectrum is attained with different spatial scales. The $k^*(\lambda)$
curves demonstrate this effect. A shift of the position of α^* for green
light in the direction of greater spatial frequencies in comparison with the
blue and red is probably attributable to the greater depth of penetration of
green light into the water and a corresponding increase in the contribution
to dual focusing from longer surface waves. It is clear that the dual
focusing effect cannot be neglected in an extremely wide range of spatial
scales and optical wavelengths. This effect exerts an influence not only in
the magnitude of the fluctuations, but also on their angular spectrum.
Figures 3; references 11: 6 Russian, 5 Western.
[132-5303]

RESEARCH SHIP 'PROFESSOR VIZE' BEGINS NORTH ATLANTIC CRUISE

[Article by A. Kozlovskiy]

[Text] The scientific research vessel "Professor Vize" set out yesterday from Leningrad for the North Atlantic.

This cruise, the 44th for this scientific ship, will last three and one-half months. Expeditionary studies will be carried out in line with a program drafted by institutions of the Academy of Sciences and the USSR State Committee on Hydrometeorology and Monitoring of the Natural Environment. Plans call for making oceanologic, hydrographic, aerometeorological and hydrochemical observations in the waters of the Norwegian and Greenland seas. This area of the world's oceans has a decisive effect on the formation of the climate of the Northern Hemisphere.

An evaluation of parameters which are components of the heat balance of the 'ocean-atmosphere' system in the North European basin will make possible more precise long-term forecasting of the weather and the condition of the ice cover in arctic seas for the upcoming shipping season.

FTD/SNAP
CSO: 1865/213

'PROFESSOR VIZE' RETURNS TO LENINGRAD FROM ANTARCTIC CRUISE

[Article by A. Kozlovskiy]

[Text] The research ship "Professor Vize", which had been conducting studies in the southern oceans under the large-scale program "Poleks-Yug", returned yesterday to Leningrad.

The latest cruise of this 'ship of science' lasted about six months. Participants of the expedition, which included representatives of the Arctic and Antarctic Scientific Research Institute, the USSR Academy of Sciences, and scientific institutions of the State Committee for Hydrometeorology and the Monitoring of the Natural Environment, carried out oceanological, meteorological, aerological and hydrographic studies in a survey area in the South Atlantic and Scotia Sea. This survey area is located at the confluence of cold antarctic waters and waters of the Atlantic Ocean.

Carrying out an assignment of the Soviet Antarctic Expedition, the "Professor Vize" visited the roadsteads of the Soviet antarctic stations Bellinsgauzer. and Molodezhnaya. About 50 participants of the previous wintering party at these stations came back on the ship to Leningrad.

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FINLAND BUILDS LIGHTER CARRIER 'BORIS POLEVOY' FOR SOVIET ARCTIC FLEET

Moscow VODNYY TRANSPORT in Russian 7 Jun 84 p 1

[Excerpt] A lighter carrier, the "Boris Polevoy", which was built to orders of the all-Union association "Sudoimport", has been handed over at the ship-yard of the state joint-stock company "Valmet" in Helsinki.

This new vessel has a displacement of about 9,000 tons and is capable of taking on board six lighters with cargo capacities of 1,000 tons each. An original solution was incorporated in the lighter loading system, which uses the method of lowering the vessel in the water.

"Valmet" has at the present time a Soviet order for the construction of a series of vessels for Arctic shipping.

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CSO: 1865/192

IL-76 DROPS MEN, EQUIPMENT BY PARACHUTE TO ARCTIC DRIFTING STATIONS

Moscow PRAVDA in Russian 17 May 84 p 1

[Excerpt] I am sending these lines from the ice floe on which the drifting
station "Severnyy polyus-27" is being set up. Here, 370 kilometers northeast
of Zhokhov Island, parachutists brought in from Pevek on two IL-76 cargo
planes have just made a group jump.

A tractor and some other cargo items the polar explorers need will arrive
at the future drifting station in the same unusual way.

A study of the possibility of using parachute systems in setting up drifting
stations in the Arctic Ocean, the delivery of large-size loads to them, and
the conduct of search-and rescue operations are envisaged in the course of
the work. For two hours, the sky over the ice floe was brightly decorated
with red, blue and green parachutes. The heavy airliners made several passes
over the polar scientists' huts before first the tractor, supported by five
canopies many meters in size, and then all the participants of the unusual
landing operation came down smoothly in the prescribed area.

The day before, the same group of parachutists and flyers had successfully
dropped 120 barrels of diesel fuel at the station "Severnyy polyus-26",
which is drifting 1,200 kilometers northeast of Zhokhov Island.

FTD/SNAP
CSO: 1865/176

'SP-27' ARCTIC STATION IN OPERATION

[Article by N. Konstantinov]

[Text] Leningrad, June 4--One more outpost of Soviet polar science--the drifting station "Severnyy polyus-27"--is in operation! The station has begun a drift northeast of the New Siberian Islands, a thousand kilometers from the mainland.

Participants of the high-latitude aerial expedition "Sever-36" organized the new station in difficult conditions. They succeeded in finding a pack-ice floe 12 square kilometers in area which was large and strong enough.

The first group of 10 scientists and specialists is headed by Yu. Tikhonov, an experienced polar researcher.

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78

SCIENTIFIC RESULTS OF HYDROGRAPHIC RESEARCH IN ARCTIC

VIL'NER, B. A.

[Abstract] An independent Hydrographic Administration directly subordinate
to the Main Administration of the Northern Sea Route was organized in 1933
on the basis of the Hydrographic Section of the All-Union Arctic Institute.
This administration later experienced a number of changes until the
Hydrographic Enterprise of the USSR Ministry of the Navy was organized in
1964. Simultaneously with the birth of the Hydrographic Enterprise the
journal SEVERNYY MORSKOY PUT' (Northern Sea Route) was established. From
almost the beginning the enterprise was engaged in active research on methods
for determining a ship's position during echo sounding work. Great successes
were achieved in the development of radio range finders; their effectiveness
under polar conditions was clearly demonstrated. The "Radiolag GP" apparatus
was developed and beginning in 1952 was used extensively in depth measure-
ments at sea. The journal SEVERNYY MORSKOY PUT', the leading publication
for dissemination of information on polar hydrographic work, was suspended
with the beginning of World War II and was never revived. Much research
continued on the development of navigation instruments and the depth
measurement process. The manual GIDROGRAFIYA MORYA (Marine Hydrography)
was published in 1964 with collaboration of the enterprise and this embodied
information on the progress of hydrographic science. Its publication helped
in the training of young specialists. The enterprise helped in organizing
a prolonged navigation season in the western Arctic, did much in support of
the cruise of the atomic icebreaker "Arktika" to the north pole and assisted
in the high-latitude cruise of the diesel-electric "Kapitan Myshevskiy" and
atomic icebreaker "Sibir'." The work of the last 50 years has yielded a vast
amount of material on the nature of bottom relief in the seas of the Soviet
Arctic, on the basis of which it has been possible to compile an extensive
collection of navigation charts. Other types of research include studies
of the dynamics of shores and bottom relief formed by permanently frozen
Quaternary deposits with inclusions of fossil ice. In 1977, taking ad-
vantage of unusually favorable ice conditions, the enterprise specialists
carried out detailed exploration of the Lomonosov Range. At the same time
a detailed study was made of a sector of the continental slope of the Laptev
Sea, dissected by canyons with local relief from 100 to 2,000 m.
[120-5303]

FURTHER DETAILS OF PARACHUTE DROP FROM IL-76'S AT ARCTIC STATIONS

Moscow KRASNAYA ZVEZDA in Russian 2 Jun 84 p 6

OLIYNIK, A., major correspondent

[Abstract] The article records comments of an organizer and of a participant in the recent operation involving two IL-76 cargo planes which transported personnel and supplies and dropped them by parachute onto the ice floes of two Arctic drifting stations. It is noted the operation had the code-name "Ekspark-84", which is an acronym for 'Arctic parachute experiment'.

Mikhail Vasil'yevich Arabin, a master of parachute sport and one of the organizers of the experiment, related that the first airlift took place on May 12, when 120 barrels of diesel fuel were dropped at the "SP-26" station. Three days later, the planes flew from Pevek to the "SP-27" station. It is noted that the coordinates of its ice floe were 78 degrees 27 minutes North latitude, and 160 degrees 58 minutes East longitude. On the first flyover, a DT-75 tractor on a platform, 20 barrels of fuel and foodstuffs were dropped. On the next flyover, the personnel jumped from an altitude of 800 meters. The aircraft's speed was 300 kph. Arabin noted that all the cargo parachute systems operated without a hitch in the adverse conditions, for which he gave credit to specialists Vladimir Rodionov and Nikolay Mikhaylov.

Aleksandr Zakharovich Sidorenko, the leader of the parachute group which jumped at "SP-27", named the members of his group. He noted that they used the PTL-72 model parachute. They hit the ice 100 minutes after takeoff from Pevek, having flown hundreds of kilometers. The group worked to clear a runway on the ice floe with the tractor, which was outfitted with a bulldozer blade.

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CSO: 1865/192

PARACHUTE DROP OF MEN, EQUIPMENT TO ARCTIC STATIONS

Moscow IZVESTIYA in Russian 27 May 84 p 1

[Abstract] The article records comments of G. Serebrennikov, Deputy Chairman of the USSR Parachute Sport Federation, and N. A. Kornilov, Deputy Director for Science of the Arctic and Antarctic Institute, regarding the recent airlift with IL-76 cargo planes to drop personnel and equipment on the ice floes of two arctic drifting stations. The operation was a test of an efficient new way of both setting up new stations and resupplying existing ones.

Regarding the drop at the SP-27 station, which is in the process of being established and equipped in the East Siberian Sea, a thousand miles from the mainland, Serebrennikov reports that 14 parachutists made a group jump and landed in a target area 500 meters square. He notes they had to train specially for jumping at the high speeds of the IL-76 airplane. The jump was made from an altitude of 800 meters in heavy cloud cover, with an air temperature of minus 8 degrees and wind velocity of 5 meters per second. A tractor also was dropped under an array of five parachutes. The parachutists were greeted by Yu. Tikhonov, head of the SP-27 station, and S. Kessel', leader of the "Sever-36" high-latitude aerial expedition.

At the existing SP-26 drifting station, which is headed by G. Voinov, a new supply of fuel was dropped by parachute in a few hours. It is noted that it used to take weeks to fly in as much fuel.

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